SCIENTIFIC AMERICAN SUPPLEMENT. No. 1188

Copyright, 1898, by Munn & Co.

Scientific American, established 1845.
Scientific American Supplement, Vol. XLVI. No. 1188. NEW YORK, OCTOBER 8, 1898. Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

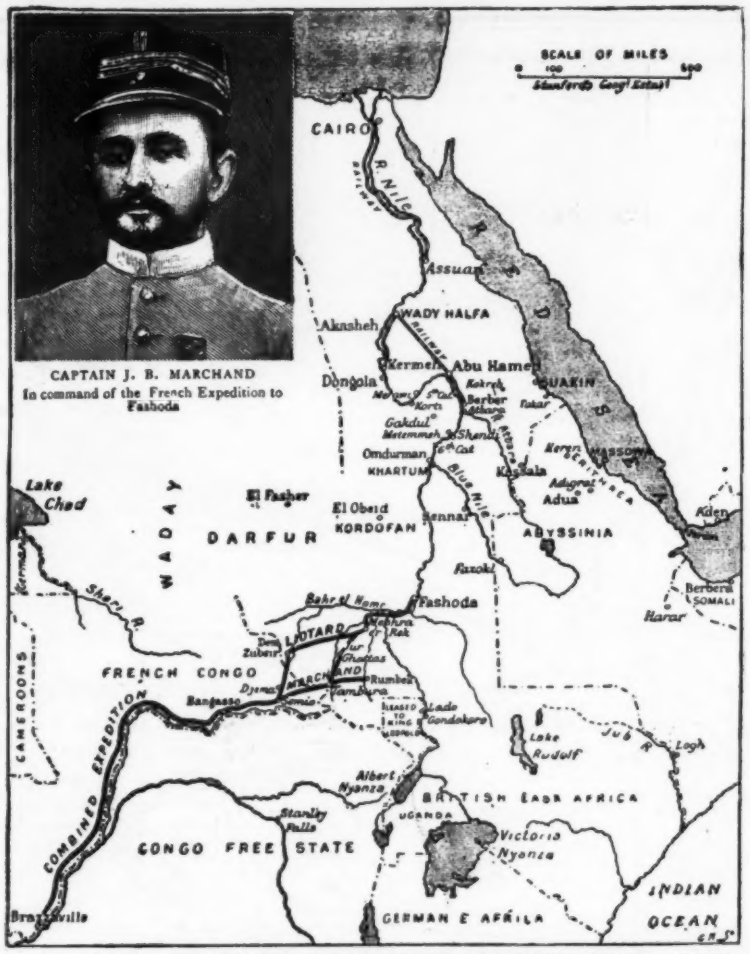
THE FRENCH ON THE UPPER NILE.

THE great question of the moment is who shall have the Bahr-el-Ghazal—the British or the French? This question has reached the stage of burning by the reported occupation of Fashoda by the French and the advance on that place of the victorious army of the Egyptian Sirdar, Sir Herbert Kitchener.

The Bahr-el-Ghazal is a former province of the Egyptian Soudan, south of Khartoum and north of Equatoria. It may be described as about five times as big as England, and is covered with forests and mountains and seamed with low valleys subject to inundation. It includes the larger portion of the basin watered by the Bahr (or river) Ghazal, which, with its affluents, the Bahr-el-Arab, Jur, Rohl, and Roa, forms a labyrinth of streams. Fashoda is situated on the Nile proper, just northward of this labyrinth, and hence commands access to all the streams which feed the great river. It is the capital of the Shilluk country, and it was annexed to Egypt nearly half a century ago. In 1869 Sir Samuel Baker, on behalf of the Khedive, carried the Eygptian flag as far south as Uganda. It was Gordon, however, who first undertook to introduce a settled administration into the Soudan, and for this purpose he appointed Romolo Gessi Pasha Governor of the Bahr-el-Ghazal. His energy cleared the province of its hordes of slave dealers, and created in the Dem, or camp, of Suleiman (also called Dem Zobeir) a capital which soon developed into the largest and busiest township on the Upper Nile. When Gessi died, Lupton was appointed to succeed him as Governor, and he held this position until the rising tide of Mahdiism flooded the province, destroyed his army, and carried him into captivity to Khartoum.

The expulsion of the Egyptians from the Bahr-el-Ghazal opened a possible route for the French across the African continent connecting their Congo colony on the west with their possessions on the Red Sea. The idea, however, only slowly took root, even in the minds of the most daring and imaginative of French chauvinists. With the progress of events, their attention became more and more fixed on this aspiration. Their activity was no doubt stimulated by the fact that England claimed the Upper Nile provinces as within her sphere of influence, and obtained the recognition of her claim in African conventions negotiated with Italy and Germany in 1890 and 1891. It is a part of the British case at the present moment that these treaties were duly notified to the French government, and that, although they were never expressly recognized by France, they were never disputed by her. Hence we have assumed that they were uncontested and incontestable.

CAPTAIN J. B. MARCHAND
In command of the French Expedition to Fashoda

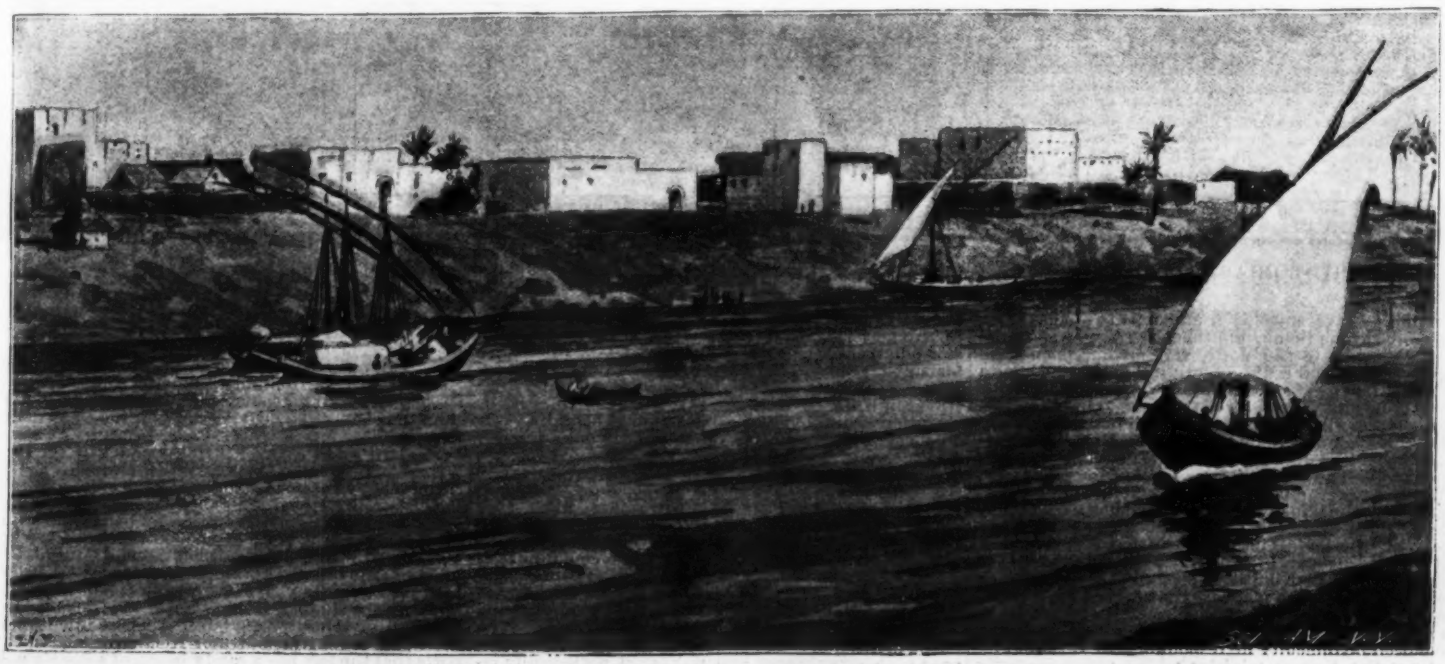


MAP SHOWING THE ADVANCE OF THE FRENCH EXPEDITIONS ON THE UPPER NILE AND IN THE DIRECTION OF FASHODA

But this assumption proved to be ill-founded. The first indication that the French intended to penetrate to the Upper Nile became apparent in February, 1894, when they negotiated a treaty with Germany in regard to the Cameroons and Lake Tchad. This treaty had the effect of opening a way for an eastward expansion of the French Congo colony. It was at once seen in this country that France had stolen a march upon us. Lord Kimberley then hit upon the idea of enlisting the friendly services of the Congo Free State, which was in a position to at once occupy and administer the province. With this view he negotiated the unhappy Anglo-Congolese treaty, which leased the Bahr-el-Ghazal and other territories on the Upper Nile to the Congo State. Unfortunately, he put too much in his treaty. By a clause providing for a road at the back of the German East African colony connecting British East Africa with Nyassaland he offended Germany, and thus aroused a formidable opposition against the agreement.

France took full advantage of Lord Kimberley's blunder, and joined hands with Germany in openly denouncing the Anglo-Congolese Treaty. Both Powers brought pressure to bear on King Leopold to withdraw from the treaty, and in due course the clauses against which they protested were, with the assent of the British government, abandoned. Then France concluded a treaty of her own with the Congo State, the effect of which was to so "rectify" the Franco-Congolese frontier that the road to the Upper Nile was definitely opened to France. By this time the French had, unofficially at least, thrown off every disguise. The object of the Franco-Congolese Treaty was stated with cynical frankness at the time by M. de Brazza, who occupied the responsible position of Commissary General of the French Congo. "This treaty," he said to an interviewer, on February 12, 1895, "assures to the French the access to the valley of the Nile. It is our duty to pursue the road open to us, and to disregard all obstacles which may be placed in our way by foreign powers. The consequence of this treaty will be our possession of the Bahr-el-Ghazal province. This is the only means we have of solving the Egyptian question in accordance with our interests."

The government seem to have been of the same opinion as M. de Brazza. M. Delcassé, the then Colonial Minister, who to-day is Minister of Foreign Affairs, gave instructions "for the formation of a column to protect French interests on the Upper Ubanghi"—in other words, to organize the advance. The scheme was well understood in France, and the French Chamber, without asking any questions, voted $400,000 for the expenses of the expedition. Col. Monteil was



FASHODA, ON THE UPPER NILE, NOW OCCUPIED BY A FRENCH FORCE.

appointed to command it. This was in the summer of 1894. In October, M. Liotard was appointed Government Commissioner in the Upper Ubanghi province, which was thus separated administratively from the Congo colony, and he steamed up the Ubanghi River and rapidly carried the French flag as far as Tambura. He then returned to Semio, where a halt was called while preparations for a larger expedition were made.

In January, 1896, Captain Marchand, of the Marine Infantry, with a further force of Senegalese tirailleurs and large quantities of stores, proceeded up the Ubanghi to co-operate with M. Liotard. The two seem to have met at Semio, where they decided upon their plan of campaign. M. Liotard, it was agreed, should occupy the western portion of the Bahr-el-Ghazal, while Marchand should occupy the central and eastern portions of the old Egyptian province. The two forces were to meet eventually at Meshra-er-Rek, whence they could steam down to Fashoda in a few days.

This plan seems to have been carried out. Liotard is known to have traveled from Semio to Djema, near the source of the Bomu, and thence to have crossed the Nile watershed to the north and advanced on Dem Zobeir. Marchand is also known to have pushed on to Jur Ghattas by way of Tambura, visiting, and no doubt annexing, Rumbek on the way. On August 21, 1897, when the last detailed news of the two expeditions was sent off from Bangasso—arriving in Europe on January 12, 1898—both forces were marching to their trysting place at Meshra.

While these campaigns have been in progress, it must not be imagined that diplomacy has been wholly idle. When, after the collapse of the Anglo-Congolese Treaty, in 1894, it became clear that French silence did not mean consent to our sphere of influence in the Nile Valley, Lord Kimberley formally asked France to recognize the British claims. He was met by M. Hanotaux with a request to be informed of the exact limits of our proposed sphere. There would, perhaps, have been no difficulty in responding to this inquiry had not the French minister added unconciliatorily that France only recognized the Sultan and the Khedive as possessing rights in the regions under discussion. Negotiations were then broken off. In March, 1895, Sir Edward Grey stated in the House of Commons that the British government would regard any invasion of the Upper Nile region as "an unfriendly act," and to this "menace to France," as Mr. Labouchere called it, Mr. Curzon publicly adhered two years later. From that time our intercourse with France on the question has ceased.

For our engravings and the foregoing article we are indebted to The London Graphic.

BOTTLE DRIFTS.

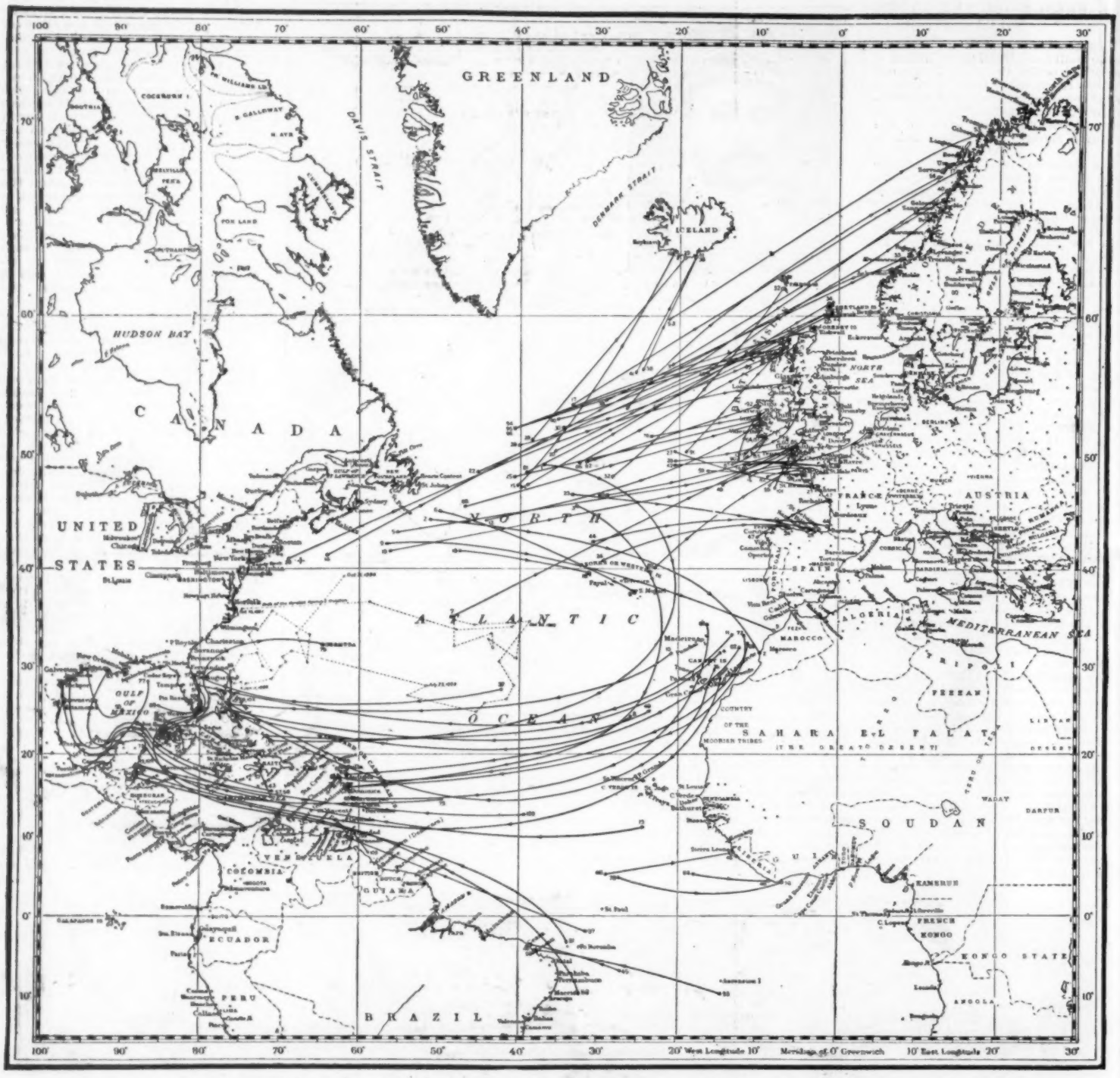
By Henry C. Weeks.

In changing quests for health, the writer found himself, in the fall of 1896, the guest of the owner-captains, on board of the only five-masted schooner in the world. So unique is the craft that she is known among seafarers the world over, and a glance at her in any waters reveals her identity. The "Governor Ames" has crossed all oceans, at one time being absent from home for three years. The story of her visit to Pitcairn Island on that voyage was interestingly told and illustrated in Harper's Weekly. She also came into public attention again by her gallant rescue of nearly the whole of a Cuban filibustering party whose steamer went down in a very heavy sea.

The writer's trip was from the Penobscot to Hampton Roads. The "Governor Ames" had got caught in the "Gulf of Maine," as it is sometimes called, that angle in the Atlantic so perverse for sailing vessels when the winds are contrary. She had been beating and beaten about for many days and could not get away. Many schemes were concocted to while away this time, and, landsman that the writer was, he supposed an original thought had entered his mind, being unaware at the time that others had experimented on bottle drifts, and that the general government encouraged such experiments and published periodically reports as to results. For a long time the Hydrographic Office of the Bureau of Navigation, Navy Department, published these reports on the reverse of their monthly pilot chart of the North Atlantic Ocean, which chart gives a summary of the month in all that interests navigators. One reverse shows "A Graphical Solution of Spherical Triangles" by Commander Charles D. Sigsbee, who was then hydrographer, but who has since become famous in far more stirring scenes.

These reports of bottle drifts are accompanied by a map of the Atlantic, on which is marked the place of starting, the probable course, and the point at which each reported bottle is picked up. From an examination of a number of the marked maps, one is forced to the theory that the surface circulation of the North Atlantic has a vast eddy between the equator and parallel 48° north, inclosing what is known as the Sargasso Sea—that strange tract of the ocean covered with the gulf weed which the Spaniards call sargazo. Nor could one doubt from the same map inspection that there is a current extending from the Gulf Stream and leaving the eddy on its north at about 30° west, which moves in a northeasterly direction. The observed courses of derelicts seem to confirm these theories of surface currents. In one of these reports it is interesting to note that one bottle drifted for 1,651 days and another for 8,500 miles. But, of course, allowances in time and distance have to be made on account of the uncertainties involved.

The writer's experiment had its sequel in the recent return to him of the postal card contained in the bottle after it had traversed at least 2,750 miles and taken in time from October 3, 1896, to February 27, 1898. It had been kept in good condition by being rolled up in oiled silk, and the neck of the bottle above the cork being filled with Portland cement. The same material had been run into the bottom for ballast. It was picked up by Mr. Duncan McPhee, plowman, of Darlochan farm, on the shore of Machrihanish Bay, just north of the Mull of Cantyre, Scotland, which is about on the same parallel as the North of Ireland. The finder reports that the bay has a sandy beach of some six miles, and that golfers and others are on it continuously; so



PILOT CHART OF BOTTLE DRIFTS OF ATLANTIC OCEAN, AUGUST, 1898.—UNITED STATES HYDROGRAPHIC OFFICE.

it is probable no time elapsed after its arrival. The mast, which had been formed by heavy copper wire, was intact, though the pennant was gone.

The drift in this instance was doubtless quite direct, the bottle having been dropped far enough north to be caught by the current which sweeps Newfoundland and crosses the Atlantic in a northeasterly direction; and it is quite as sure, from the results of former tests, to conclude that, if it had been dropped a little further to the south, it would have been carried by the eddy toward the coast of Africa and thence around the oval onto the West Indies or even into the Gulf of Mexico.

Referring to the chart which accompanies this article, No. 26+, located not far from New York, and near latitude 40, is the point where the bottle was thrown into the ocean; following the line eastward, it will be found to terminate near Glasgow, Scotland. The various other lines of bottle drifts convey an excellent idea of the general movement or trend of the ocean currents. Concerning No. 26+, the August, 1898, Hydrographic Pilot Report says: "No. 26 of present list, for instance, which was cast adrift off Nantucket shoal and recovered near Campbelton, on the coast of Kintyre, Argyllshire, Scotland, after the lapse of 512 days, the great circle distance between these points being 2,587 nautical miles, giving an average daily velocity of 5·1 miles, shows a close analogy to No. 16 of the list of July, 1897, the latter having been cast adrift off Cape Cod, and recovered on the coast of Cornwall, the distance traversed being about the same, and the time 600 days."

In the same paper occurs the following general observation: "In the extra-tropical region of the North Atlantic we have a steady eastern motion, due to the action of the prevailing westerly winds. Here again a separation of the waters occurs, and bottles cast adrift along the transatlantic routes west of the twenty-fifth meridian are found scattered along the entire western coast of Europe and Africa from Cape North to the Canaries. East of the same meridian they ordinarily seek the shores of Great Britain and France."

The following is the message written on the back of a United States postal card and carried to Scotland in bottle drift No. 26+:

On board five-masted schooner "Gov. Ames," of Providence, R. I., U. S. A., bound from Bangor, Me., to Newport News, Va. Latitude 40.53 N. Longitude 69.10 W.

Saturday, October 3, 1896, 12 noon.

Following is the list of persons and their guesses when and where this card in sealed bottle will be picked up:

C. A. Davis, master, 8 months, east of Gulf Stream, at sea.

Gust. Waldemere, mate, never found.

F. S. Davis, passenger, summer 1897, Martha's Vineyard.

W. W. Arnold, passenger, two years, Nantucket, Mass.

H. C. Weeks, passenger, six months, west coast of Ireland.

Will the finder please confer a favor by filling the blanks and mailing the card or inclosing it in a note, for which five cents postage will be found in the bottle.

Finder, name, and address.....

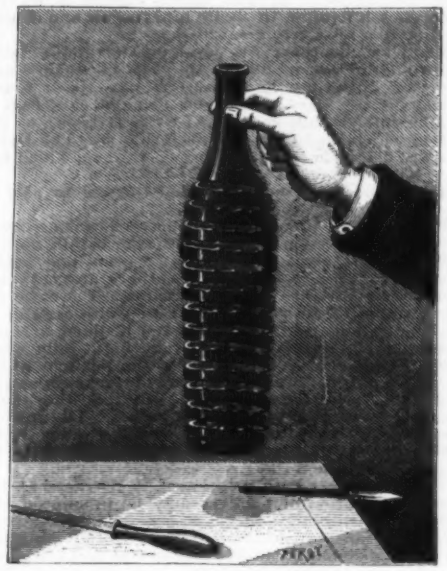
Date and place.....

THE EARTHQUAKES IN DALMATIA.

ON July 2 the district of Sinj, in Dalmatia, was visited by earthquakes which were much more severe than those experienced at Laibach in 1895.

Sinj, a market town of three thousand inhabitants, is situated twenty-two and one-half miles northeast of the port of Spalato. It lies, with fourteen little villages, on the edge of a valley or basin at the western foot of the Dinaric Alps, which must once have been a lake. Now the little river Cetina runs through the basin in a northerly direction and empties into the Canale della Brazza, a channel of the Adriatic, its waters being augmented by those of the little streams Ruda and Grab, which have their source in the Dinaric Alps. In winter the Cetina overflows its banks. The rich mould of the valley covers a conglomerate which abounds in cavities, while chalk and argillaceous earth are found along the edges of the basin.

The first severe earthquake shock was felt at 5:19 A. M. on July 2. The strong wind called the "bora" had been noticed about twenty seconds before, and this was followed by subterranean rumbling resembling thunder; then the trembling motion began, which lasted about eight seconds, with an intensity of IX on the Forel scale, and then all was perfectly quiet. About ten seconds later a less severe shock was felt, which was accompanied by a rumbling sound, and after another interval of ten seconds a still slighter shock was felt. After this the shocks, which were always accompanied by a noise like thunder, succeeded one another at almost regular intervals of an hour.



THE SPIRAL BOTTLE.

Two days later the shocks were repeated, and then they occurred daily, but at much longer intervals, until the 16th. On July 6 and 7 there were thunder showers with a heavy fall of rain, and on the 17th there were more earthquake shocks which surpassed in severity all except the first. Shocks lasting from two to three seconds then occurred two or three times each day, between 2 and 6 A. M. During the last days of the month the shocks were continuous.

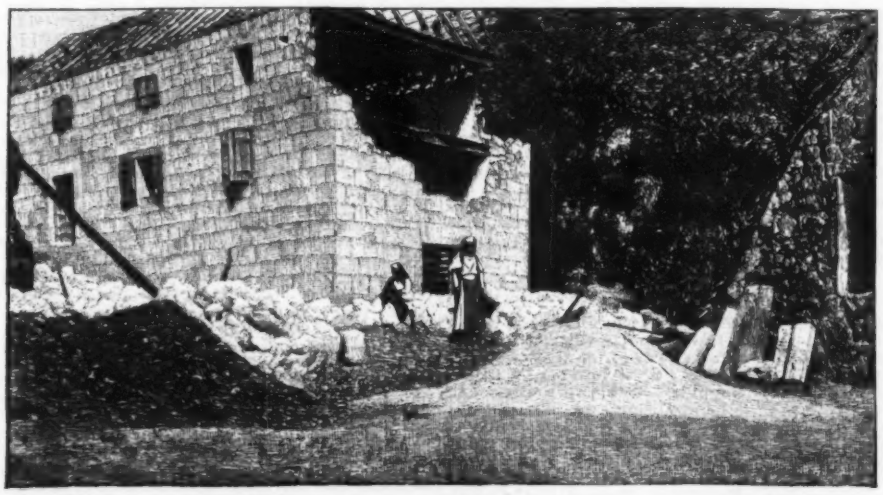
The first severe shocks of July 2 displaced many things and cracked the walls of the houses, which were built of broken stone, so that they swayed back and forth, groaning, while the subterranean noises sounded as if a hundred wagons were being driven over the roofs at a great speed. This describes the condition of things in Sinj, but in the villages situated about four to eight miles to the southeast of Sinj—Turjake, Vojnic, Kosute, and Trilj—most of the dwellings were totally destroyed, for there eighty-seven severe shocks were felt, while in Sinj there were only twenty-five, between the 2d and 23d of July.

These terrifying disturbances of nature manifested themselves in different ways, sometimes as shocks with, and at other times without, noise; sometimes there were alarming sounds without any motion; sometimes these sounds resembled the booming of great guns or the explosion of a mine; and sometimes it seemed as if the shock took effect underground and was lost in empty space.

People who remained in the open fields during this time say that the ground split wide open and then closed up again, and a light mist spread over the land. The Cetina overflowed its banks, and when it returned to its bed many fishes were left under the bushes.

There is no doubt that these disturbances were of a strictly local nature, as their zone included only a portion of the Sinj basin, and the supposition that their center was at Turjake seems most plausible, because there the most extensive crevices were formed and there all the buildings, and even low walls, were completely demolished. From there the seismic waves extended in opposite directions, the stronger ones southward toward Vojni, Kosute, and Trilj, and the weaker ones northward toward Sinj. Unfortunately, it is to be feared that the occurrences of July are only the beginning of a long period of earthquakes in Sinj and the surrounding country, such as has visited Agram and Laibach.

Thanks to the circumstance that most of the inhabitants of these villages had left their dwellings at an early hour to attend to their work in the fields, there was comparatively little loss of life; the total number of those killed was only six, but eighteen were badly and twenty slightly injured. All the people are now living in tents.—Illustrirte Zeitung.



THE DESTRUCTION IN VOJNIC.

THE SPIRAL BOTTLE.

PERFORMERS of tricks sometimes exhibit bottles cut into elastic spirals like glass springs. They may be made as follows: Form a crayon from a paste composed of 6 ounces of lampblack, 2 ounces of gum arabic, 6 drachms of gum tragacanth, 6 drachms of benzoin, and a sufficient quantity of water; then, having heated the crayon to redness in a flame, apply it to the glass wherever the latter is to be cut. The cut is begun with a scratch made with a file, and the slit is then continued with the crayon sharpened to a point, and, as above stated, heated to redness. The incandescence of the crayon is increased by blowing upon it with the breath.—La Physique Sans Appareils.

A NEW INCANDESCENT FILAMENT FOR ELECTRIC LIGHTS.

THE German Journal for Gas Lighting of recent date contains some highly interesting information upon what is perhaps the most important new topic in the science of illumination, namely, the improved incandescent filament for electric lamps, which has just been announced by Dr. Auer von Welsbach, the distinguished inventor of the incandescent gaslight which bears his name. It was but natural that, having perfected the device which increases so remarkably the illuminating power of gas, Dr. von Welsbach should seek to develop some similar improvement for the application of electrical currents to illuminating purposes.

This he appears, from the somewhat meager published accounts, to have found in a filament of osmium, one of the rare metals, which, besides being the densest of all metals, is the most refractory, being infusible at any except the highest attainable temperatures. Osmium is found native as an alloy in certain ores of platinum and iridium. It is a hard, bluish gray metal, with an atomic weight of 191·1, and the enormous specific gravity of 22·477, the heaviest substance known. Its tetroxide has a strong odor of chlorine, from which circumstance its name was originally derived.

But the property which must have suggested osmium as the material of the new electrical filament was its practical infusibility, its known resistance to temperatures in which platinum and iridium volatilize and disappear. It is well known that the intensity of light emitted by an incandescent substance increases rapidly with its absolute temperature. By heating osmium in a vacuum with an electrical current strong enough to volatilize platinum, it attains a luminosity hitherto almost unknown, emitting a white light of agreeable quality and color, but of great intensity.

So far as can be inferred from what has been published, the experiments of Dr. von Welsbach go quite beyond the employment of a naked osmium filament, and include coating the metal with a refractory oxide like thoria.

It has long been known that a platinum wire or filament, through which a sufficiently strong current is passed, attains a white heat and then suddenly melts. If, however, the filament be coated with a highly refractory oxide like thoria, the temperature required to melt it is greatly increased, for the reason that part of the electrical energy is withdrawn from the metal to its oxide coating and is radiated in the forms of light and heat. Precisely the same result happens when the filament coated with oxide is of osmium, instead of platinum, and the resistance of the filament is still further increased to the extent that osmium is in itself more infusible than platinum.

There is thus obtained a filament capable of sustaining a temperature and consequent intensity of illumination hitherto unachieved by such means, and it is this which forms the germ of the present invention of Dr. von Welsbach. It has been noted in his experiments that osmium used for this purpose must be almost chemically pure, and that commercial forms of that rare and costly metal require, before using, to be cleansed as far as possible of all impurities except platinum, a small admixture of which renders the osmium more elastic without sensibly diminishing its infusibility. The whole effect of the invention, if practically applied, will be to advance in an important degree the limit of electrical energy which may be used in incandescent lighting, and thus reach a new standard of economy in the production of artificial light, which is cheapest at the intensity obtainable only at high temperatures.

Osmium, according to the trade catalogue of a leading German chemist, costs $1.10 for 20 grains; so that if the new filament should become successful in general use, there will be a demand for a larger supply of that metal at a more moderate price.

FRANK H. MASON, Consul-General.

Frankfort, July 5, 1898.

From coal is produced a variety of substances, of which alcohol appears to be the latest. According to Herr P. Fritzsche, the gases of coke ovens are specially suitable for the recovery of alcohol. He has gone carefully into the matter, and on reducing to alcohol the ethane contained in the issuing gas, he found a content of 1 to 1·8 per cent. by volume, and upon studying the speed with which sulphuric acid absorbs ethane, he concluded that the absorption process is perfectly practicable, the apparatus for ethane recovery from coke oven gases being considerably smaller than that for benzol separation. Herr Fritzsche calculates that for the production of 26·5 gallons, equal to 176 pounds of alcohol, 107 pounds of ethyl sulphate, 771·6 pounds of concentrated sulphuric acid, and 1,102 pounds of water are required. Here is a matter for the excise to investigate in connection with by-product coke ovens.

THE DISPERSION OF MOLLUSKS.

Nature, in fixing plants to the soil by their roots, seems to have deprived them of the faculty of dispersing themselves over the surface of the earth. It has very fortunately modified this law, which is inconsistent (in appearance only) with that of the multiplication of the species, by providing their seeds with organs that permit various natural agents to carry them to a distance and thus assure their dissemination.

The mollusks, which are fixed to rocks or are, at the best, provided with very rudimentary organs of locomotion, seem to be in a situation analogous to that of plants; but they have not, like the latter, seeds that are winged or provided with hooks through which the wind or animals may carry them far away from their place of origin. The study of the means of dispersion of these animals, which are sedentary by nature, has been somewhat neglected, and it is only in recent years that any attention has been paid to it.

Mr. Harry Walles Kew has published in the International Scientific Series a very complete work upon this subject, the most interesting parts of which we propose to summarize.

The geographical distribution of the fresh water mollusks and their local distribution in masses of isolated water necessarily proves the existence of means of dispersion. The individuals have been carried from one place to another, from one lake to another, and from a continent to the most isolated islands of the ocean.

The most prevalent objection that is made to the possibility of such carriages is that these mollusks have not the faculty of living long out of water; but this is an error due to the absence of direct experiment. Several of these mollusks are amphibious, and one pond-snail (Limnæa truncatula) is as much at home out of water as in it.

Prof. Thomas kept several specimens of this snail in an open vessel containing no water and placed upon a table in a laboratory into which the sun shone several hours a day, and found that half of them were still living at the end of thirty-six days, while others held out for six weeks.

Mr. Christy found that a viviparous Paludina that got out of an aquarium by accident and remained three weeks out of water appeared to have suffered no harm therefrom.

A fresh water mussel wrapped in paper, and sent from Cochin China to England, arrived, through force of special circumstances, only at the end of 498 days; but, upon being placed in an aquarium, resumed its habitual life. Finally, a few specimens of Ampullaria, placed in a vessel, lived for five years in the hot climate of Calcutta. Such resistance to death, which is common to a large number of species, and many other examples of which might be given, certainly favors the carriage of mollusks to a great distance.

Of the many curious and interesting facts given by Mr. Kew, we shall at present mention only those that have reference to the dispersion of fresh water molluscous bivalves.

The occurrence narrated in the fable of the rat and the oyster is often reproduced in nature. The mollusks, in closing their valves, so strongly grasp the object that has been introduced between them as to be carried along when it moves away. Country people, who make skimmers out of the shells of fresh water mussels (Anodonta cygnea), procure these mollusks by means of a pointed stick, which they introduce between the partially open valves. As in the fable, the mussel quickly closes its valves and grasps the stick. At this moment the fisherman lifts the latter and the mussel along with it. Our author allowed an Anodonta captured in this way to remain suspended out of water for fifty-one hours, and when he put it back into the liquid it detached itself. This method of capturing mussels is very ancient, for Sir Robert Redding, in 1688, stated that the poor of the North of Ireland caught pearl mussels, some with their big toe and others with a sort of wooden tongs. Birds, in wading in marshes or upon river shores and in ponds, often put their feet upon mollusks, which avenge the act by quickly closing their shell; and in this way they become attached to the bird, which carries them to other localities.

It is claimed that in the State of Virginia it is impossible to raise ducks on account of the species of Unio, which seize the legs of the ducklings at low tide and hold them until high water, when they perish through drowning, since they have not the strength to lift the mollusk.

The instances of dissemination by insects are more rare and more difficult to observe, but are none the more curious for all that.

There may be seen in the Manchester Museum the larva of a Libellula, to one of the legs of which is fixed a Sphærium corneum (Fig. 1). Such an instance is not of great importance from the view point of dispersion, since the Libellulæ are not very great travelers. The same is not the case when these small mollusks attach themselves to aquatic insects capable of leaving their chosen habitat, of flying into the air and of proceeding to a relatively great distance.

Mr. Kew mentions five examples of Nepes (well-known large coleoptera) to the legs of which specimens of Sphærium and Pisidium have been found fixed (Fig. 2). Darwin mentions a similar case, that of a Sphærium cornutum, carried by a Dytiscus, to the legs of which it had fastened itself (Fig. 3). The Dytiscus was placed in an aquarium, where it remained five days with its commensal attached to it.

The mollusks sometimes fasten themselves also to the antennæ of insects or crustacea.

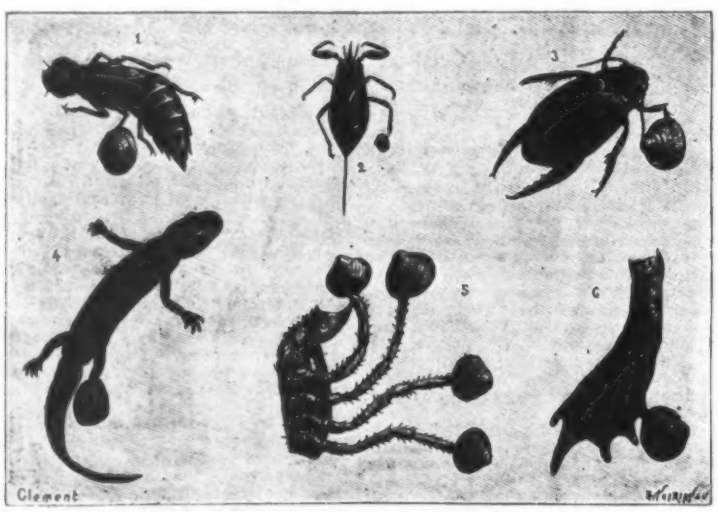
In order that aquatic insects may efficaciously concur in the dispersion of mollusks, even within quite a circumscribed area, they must fly from one watercourse or pond to another. Authors are not thoroughly certain as to the aerial habits of aquatic insects, and as to the voyages that they are capable of making in the air. Canon Fowler is inclined to think that the Dytisci, for example, take flight only when they are obliged to, that is, when the pond in which they live is dry. But, on the contrary, Darwin asserts that these insects fly at night, and that they have often been found upon window sashes. The insects, deceived by the brilliant aspect of the window panes, which they had taken for the surface of water, remained upon the frame.

From the facts just mentioned, it results that the local distribution of bivalves may be influenced in a certain measure by aquatic insects. A violent wind also may transport insects that are carrying mollusks, and thus disseminate interesting species to a distance.

Frogs, toads, salamanders, etc., are, too, quite often captured with mollusks attached to their feet. The first mention of a capture of this kind dates back to 1829. Mr. Knapp tells us, in the Journal of a Naturalist, how curiously he was impressed at the sight of a salamander dragging along a mollusk in spite of itself (Fig. 4).

Other animals, too, may have a mollusk attach itself to some part of their body. Mr. Todd relates an instance of a turtle that walked about for a long time with a Unio attached to its jaw. Prof. Girard found in Seine-et-Marne some crawfish with specimens of Cyclas fontinalis attached to their legs (Fig. 5). In some cases the entire eight legs had mollusks attached to them. Prof. Rossmässler points out the fact that the Dreissena polymorpha often attaches itself to the tail of crawfish by means of its byssus.

As we said in the beginning, it is a question here only of the dispersion of bivalves. Some other time we may study the means of dissemination of univalve mollusks.—La Nature.



THE DISPERSION OF MOLLUSKS.

1. Larva of Libellula carrying a Sphærium. 2. Nepe carrying a Pisidium fontinale. 3. Ditiscus with a Sphærium corneum attached to leg. 4. Salamander with a shell fastened to the leg. 5. Crawfish with shell attached to the leg. 6. Foot of toad with shell attached.

THE MINERAL RESOURCES OF PERSIA.*

The mineral resources of Persia are but little developed, notwithstanding the ancient civilization of the country. Gold mines are known in a number of places, but either their remoteness or the low grade of their ore militates against their exploitation at present. In the fourteenth century gold washing was carried on at the northern edge of the great salt desert, south of Damghan, along the Kuh-i-zar (mountain of gold). The gravel washed there assayed 2 to 3 gms. per metric ton.

The Bulmus-Bash Mountains, situated to the north of Kavend (28 km. west of Zend), show gravels containing 0·3 to 0·4 grm. gold per ton. About 1 km. from Kavend there is a limonite mine in limestone, together with quartz veins containing hematite and assaying 0·311 grm. gold per ton. Some springs at this point are depositing iron oxide, which, upon assay, showed a maximum of 0·525 grm. gold per ton. In the mountains at Turkobeh (Turkoveh), west of Meshed, old gold mines opened on quartz veins in mica slate are reported. Gold bearing quartz veins are also noticed 2 or 3 km. west-southwest from Meshed, as well as west of Meshed, near Turkobeh. In the same vicinity, at Fahr Daud, near Boznishk, there are old copper mines, filled with water; the alluvial sand near them assays, if the samples are to be believed, 11 grm. gold per ton.

Silver mines are noted between Tasan and Zahadan, in Southern Persia, in the vicinity of Dastah, in the Kuh-i-nugre, but the kind of ore is unknown. The mines in the Sahend Range, in the vicinity of Tabris, bear stephanite, pyragrite, and tetrahedite. In the Zendjan district a silver mine is developed 1 km. northwest of Murassu (38 km. west-southwest of Zendjan), in the Turbet Mountains. The vein, which is in granite, contains quartz and pyrite, the ore assaying 46 grm. silver per ton. On the Arghun Mountain, near the headwaters of the Anghuran River, about 15 km. east-northeast of Tahkt-i-Soleiman, there is a silver-lead mine, and another further northwest, named the Uriard mine. The veins, which traverse mica-slate breccia, are 1·5 to 1·20 cm. thick, and carry much cerussite with white calcite and red fluorite. They are developed by 7 shafts about 100 m. deep, sunk through old workings, which are dangerous to the miners, caveins being frequent. Out of the 110 persons employed in them 2·5 per cent. are killed annually. The mine pays an annual tribute of about 400 francs to the government and produces about 15 tons of argentiferous lead, yielding by cupellation 346 grm. silver per ton. In melting the ore, 5 parts assaying 50 per cent. lead are reduced with one part of charcoal. North of these mines, in the same valley, there are veins of fluorspar in mica slate, but the use of fluorspar as a flux is not known. A very ancient silver-lead mine is reported at Afshar, on a tributary of the Saruk River, 18 km. from Tahkt-i-Soleiman, where veins of reddish gangue with quartz and argentiferous galena traverse limestone introbedded with slate; the mine is developed by 7 shafts sunk to the depth of 40 m., and the argentiferous lead obtained is said to yield 676 grm. Ag per ton. Silver mines are also reported near Djirunft (Djufra on Russian maps), about 50 km. southeast of Kerman (Ghavashir), and in the Basru Mountains, between Ghavashir and Tars, and near Rey, which is the Rhages of the Bible.

Quicksilver ore is supposed to occur in the basalts near Sandjiek, Kiz Kapan, Karakeia, three villages in the Afshar mining district previously alluded to, which is noteworthy, since cinnabar has also been detected in the auriferous gravel at Zarashuran.

Copper ores are very common in Persia and copper was exported in former times, but since most of the mines are now abandoned, it is difficult to determine which of them might be workable. The Sahend Range, near Tabris, bears deposits of caprite, bornite, and other ores.

Tin ores are supposed to occur in the Asterabad district in northeastern Persia and in the Tabris district in northwestern Persia. Ancient writers mention tin in the vicinity of Dragan in Ariania.

Antimonite exists in Persia, though its localities are unknown to European mineralogists. It is sold at Teheran under the name surmeh for blackening the eyebrows, for which purpose it is used by all the Mohammedan peoples. Many mountains, designated Kuh-i-Surmeh, indicate deposits of this ore. Not far from the Afshar lead mine there are stringers of antimonite, 4 to 5 cm. thick, in limestone, but it is not known if the deposit is workable.

Realgar is mined in the Tahkt-i-Soleiman Mountains, in the Aserbeishan district, 14·5 km. from the northern fork of the Saruk River. The country rock is slate, penetrated by melaphyres and basalts. The realgar occurs in veins 0·33 to 0·50 m. wide at the contact of melaphyre and slate. The mines are worked under lease from the government for a royalty of 7·5 tons of first grade realgar per annum. This grade of mineral sells at Hamadan at 330 francs per ton. The second grade brings 170 francs, and the third 100 francs. The mines employ 8 men, who work seven months of the year, the region being inaccessible in the winter.

Five hours north of this mine, near the village of Goramis, there is another occurrence of realgar, accompanied by orpiment, in thin veins. Occurrences are also noted in the vicinity of Kazvin, and near the Afshar lead mine.

Sulphur is found in Persia at numerous points. It is obtained from the crater of the old volcano Demavend, east of Teheran. Southeast from Tash, in the Alberus Range, there are marls impregnated with sulphate of aluminum and sulphur. There is a sulphur producing region in northwestern Persia, between Mesjed-i-Suleiman and the Asmari hills. The product is sold at Dizful.

Sulphur occurs in a soft, earthy rock on an ancient mud volcano near Zendan, in the Aserbeidshan district. This deposit is worked, the product being sold in the city of Zendjan. A few kilometers west of the realgar mine, in the Tahkt-i-Soleiman Mountains, there is a sulphur mine which employs about 60 men in summer. Sulphur also exists 8 km. from Coramis, in the Kourdish Mountains.

The distribution of iron ores is very extensive. Argillaceous limonite accompanies the Liassic coal seams and clays. The Liassic sandstones are rich in embedded spherosiderite as in the forest region of the Heras River, where ore assaying 74 per cent. Fe_2O_3 was dug, and smelted before the cheaper Russian iron came into the market. Similar deposits are found also in the Chilan Range.

Thick veins of limonite and hematite in quartz are found near Kasvin and Takht-i-Soleiman in Aberseidshan. At Kara there are ores running about 60 per cent. iron. On the River Angerd there are deposits of limonite and hematite ores. In the district of Teridan, on the northeast slope of the Zerdi-Ruh Mountains, hematite and martite ores running up to 55·59 per cent. iron are found in beds between micaceous limestone and limestone. Some mining was done there and a blast furnace was started by some Scotch operators. The enterprise did not succeed, and was abandoned. Extensive deposits of hematite ores are known in the Kahrud Mountains. Iron ores are also found in the dioritic rocks of some of the islands in the Persian Gulf.

Manganese ores are worked in a small way near Kirman. The only use made of this ore in Persia is to color glass.

Cobalt ore occurs near Yamsar, in the district of

* Written for The Engineering and Mining Journal by R. Helmhacker.

Kashan. It has been worked in a small way for many years, the cobalt oxide being used for coloring pottery. Cobalt and nickel have been found in the Sheumiam Mountains, near Imam-radeh-David, and in the Sahend Mountains, near Tabiz.

Turquoise is the principal gem found in the country, and has been mined from an early date. Ancient mines are found near Maiden—the ancient Pashan. The mines have been worked for a very long time—perhaps even thousands of years—and still yield good stones. They are on the southern slope of the Alberus Range, in the province of Khorassan, and on the border of the Persian salt desert. The ridge where the gems are found is a decomposed porphyritic trachyte, tinged below the surface with iron oxide, and covered with strata of limestone and tuffs. In the trachyte are found disseminated short veins, composed of limonite, with occasional pockets of turquoise. At these mines there were recently no less than 266 pits, many of them abandoned. The deepest is 42 meters. The pits are not timbered and the methods of mining are primitive. The mines belong to the government, and the right to work them is leased only for a limited time; a system which prevents any permanent improvements. The gems obtained are sent chiefly to Teheran and to Russia. The yearly output is valued at about 200,000 francs. A few stones are found in the alluvial deposits at the foot of the mountains. Only the blue stones are valued, those of greenish tint being rejected.

There are also old mines at Kerman and Kavik: also at Mashiz, on the slope of the Cheheltan Mountains. There the gems are found in fissure veins, and the same is the case at Tabaz in Khorassan. Recent discoveries have been made near Yezd and at Seistan. At the mines of Bar-i-Maden most of the stones are now obtained by working over the old dumps. It is said that the gems obtained from fissure veins do not change color like those found in the soft decomposed rock.

In Persia the commoner and more useful minerals are found in many places, but have been little developed or used. Limestone is found in many places, and there are beds of it which will take a polish and finish like marble. True marble is also found. Other building stones are abundant, and roofing slate is found in Masanderam.

Kaolin is found at Kerman-shah. Mineral paint is dug near Ispahan. Fuller's earth is found at Kum, and pottery clay in several places. A peculiar whitish clay, found near Kum also, is eaten by the people. This is a singular custom, and is not unknown in some parts of Europe and the United States.

Coal is found in the Alberus Range, running southward from the Caspian Sea. It is also found in the country drained by the Shahrud River, and along the Kevetch River. There are many outcrops in the districts mentioned and coal taken from them has proved to be of very good quality. Brown coal or lignite is found near Tabriz, outcropping in a seam 1·50 meters wide.

Petroleum is found in the Tertiary deposits on the southwest border of the Persian highlands. It is apparently abundant in the section bordering on the Persian Gulf. Along the gulf shore there are oil springs which were known at a very early date, and were described by Strabo in the second century. Oil springs are also found in the Bakhari Range in Southern Persia, near the Dalakhi River, on the road from Abushir to Shiraz. In the Darab Mountains there are springs where the crude oil has oozed out and gradually solidified into a sort of asphalt, or asphaltic bitumen. A deposit of asphalt is found at Zendjari.

Salt occurs very abundantly in Persia, both as rock salt and in saline lakes. The rock salts are found in embedded in the Tertiary miocene series. Rock salt is mined extensively at Sherifabad, on the slope of the Nishapur Range. In Southern Persia salt is mined at several points. It is found on several islands in the Persian Gulf. Over a large part of the country are found salt or bitter lakes. The largest and best known of these is the Urumiah Lake, in Azabiran, which contains brine of extraordinary strength, sometimes carrying as high as 18 per cent. of pure NaCl. The lake is 8 meters deep in places, but will not average over 4 meters. The shallow lake dries out partially in the summer, leaving its bed crested with white salt. The Bakhtegan Lake, in Taristan, is also large, and there are many smaller ones.

Borax is produced in many places, and is found most abundantly on the border of the Sivdjan salt desert.

Alum is found at Zadikan and several neighboring places. There is a yearly production of 550 to 600 metric tons. The value ranges from 50 to 235 francs a ton according to the purity of the salt. In the Sia-ruh salt desert, north of Teheran, alunite rock is mined. At Ravir, in Eastern Persia, alum is made, and an old chemical process, long forgotten in Europe, is still in use. In this 50 parts of alum are treated with 50 parts of saltpeter by distillation, yielding 12½ parts of nitric acid.

Saltpeter it found in some places as an effervescence on the surface of the ground, and at other points in caves. The country near Teheran abounds with ancient burial mounds, from which saltpeter is obtained by lixiviation. The quantity produced cannot be ascertained.

Persia has large mineral resources, which might be developed under better government, but the present production is very small.

THE MANCHINEEL OR MANZANILLA TREE.

ON the seashores of most of the islands of the Caribbean Sea, especially abundant in Cuba, Puerto Rico, and their outlying islets, likewise indigenous to the more southern coasts of the Mexican Gulf and the Spanish Main, is found an evergreen tree, frequently fifty feet in height and yielding a somewhat tempting looking fruit, but apparently greatly avoided by living creatures. Birds are not found in its foliage, monkeys never ascend its branches, even lizards avoid its trunk. This is the Hippomane mancinella of botanists, but vulgarly known as the manchineel or manzanilla tree. The same species exists, though somewhat sparingly, along the extreme southern seacoast of Florida.

Belonging to the Euphorbiaceæ, a family noted for yielding acrid and toxic exudates, it obtains its generic title of Hippomane because it is supposed, when its foliage is taken into the equine stomach, to induce a species of madness or insanity; but the evidence that any horse or mule ever sought to allay its hunger from this source is utterly lacking. Formerly all the tales accruing to this growth were of the most exaggerated nature. It was affirmed to be more deadly than the far-famed and greatly maligned upas of Java and Sumatra; that grass will not grow beneath or within the range of its shadows; that fatalities invariably overtake those who venture to avail themselves of its shade; that a drop of the sap from its woody fiber, the exudate from its leaves, and even the moisture obtaining to its smooth, brownish bark, falling upon the skin, induces effects precisely similar to those accruing to contact with molten metal; and finally, that any creature partaking of its leaves, flowers, or fruit is at once rendered hopelessly rabid.

A BRANCH AND FRUIT OF THE MANCHINEEL TREE.

That all the exudates of the manzanilla are pernicious, dangerous, in rare instances perhaps fatal, hardly admits of doubt. They, alike, whether from fruit, leaves, branches, or stem, are capable of inducing painful and persistent inflammatory disturbances upon the skin, disturbances greatly enhanced should any mucous surface be likewise involved. In this respect, the manzanilla greatly resembles the Rhus family, especially the Rhus toxicodendron, commonly known as "poison ivy," "poison oak," "poison sumac," "poison dogwood," etc.; but rhus is more irritating to the skin, manzanilla most so to the mucous membrane. As with rhus, poisonous effects are enhanced or limited, as the case may be, by individual susceptibility; and also, by repeated contacts, the untoward action is decreased.

The dark, green leaves of this growth are oval, pointed, dentate, from 3 to 3½ inches long and perhaps half as broad, with two glands at the junction between the blade and short footstalk, and from the latter, when bruised or broken, exudes the acrid, sticky, highly irritating juice that is generally the chief agent of mischief, though, as already remarked, all juices and exudates pertaining to the tree are poisonous.

The flowers grow in thick, short spikes at the end of the short, thick branches, those at the base being solitary and fertile, those at the apex staminate and in clusters, all obscure and without petals.

The fruit is generally of a pale yellowish, or yellowish green hue, except when dead ripe, when it is decidedly ocherous, presenting the form and general appearance of a small apple—hence the popular designation of manzanillo (little apple), a term that is by no means specific or generic, since it is carelessly bestowed by Hispano-Americans upon any similarly shaped fruit, just as any tree or growth possessed of leaves and flowers of apple-like odor is denominated manzanilla.

Of the acridity of the manchineel fruit, strange and frightful tales are in common vogue, fortunately, for the most part gratuitous. Death is said to be the common result when it is tasted, but the danger is really limited to badly excoriated and blistered lips, tongue, and mouth—no one has ever been able to reach the swallowing act; and these excoriations are sometimes most difficult to heal.

Presumably the juices, as well as the bark and wood, owe their untoward properties to the presence of some acrid, acid-like constituent similar to that yielded by the Rhus toxicodendron (toxicodendric acid), and, as toward the latter plant, it is probable there are individuals so sensitive to the poison as to be unable to closely approach the growth with safety; hence the belief its shadow may prove toxic. It has also been claimed that toxic effects have resulted from contact with raindrops that fell through the tree or rolled off its leaves—a claim open to some degree of suspicion. Seeman, the botanist, was terribly poisoned, and rendered blind for several days, after gathering specimens—doubtless touched or rubbed his eyes with fingers that had been brought in the closest possible relation with the leaves; and the boat's crew that accompanied him also were made blind by gathering some of the manzanilla branches to kindle a fire. Seeman seems doubtful whether it was handling the wood or some acrid material volatilized in the smoke that caused the sailors to suffer.

Despite the unpleasant character of the growth, its wood is in considerable request for cabinet work, inlaying, etc., and affords beautiful contrasts of brown and white when seasoned and polished. Before felling, the woodmen invariably surround the tree, or trees, with a cordon of fires, believing the heat neutralizes the poison, partly by driving off some volatile constituent, partly by drying and solidifying the sap and exudates. Those who work in the wood, also, fearing the irritating effects of sawdust and minute flying particles, are wont to protect their eyes, faces, and lungs by fine veils.

Within the last decade attempts have been made to introduce manzanilla leaves and their exudate into therapeutics, but with no definite results. The milky exudate has been claimed as a diuretic and emmenagogue, the dried leaves as diuretic and diaphoretic and a specific for enuresis—much the same as has been claimed for rhus. Finally the wood has been heralded as an excellent substitute for guaiac. The tincture of the dried leaves seems to have much the same action, physiologically, when taken into the animal economy, as cantharides; it excites the same stranguary and excruciating suffering, and its use is likewise apt to be succeeded by evidences of paralysis of the cystic viscus, that fortunately appears to be but transient.

G. ARCHIE STOCKWELL.

VERONICA DIEFFENBACHII.*

WE are indebted to Mr. Lindsay, of Kaimes Lodge, Murrayfield, for a specimen of this very rare Veronica. It is a hardy shrub, about 2 feet high, with thick, leathery, oblong-acute leaves. The flowers are in axillary spikes, and of a lilac color. It is a native of the Chatham Islands.—The Gardeners' Chronicle.

VERONICA DIEFFENBACHII—FLOWERS OF A LILAC COLOR.

GREENHOUSE HEATING.

By THOMAS N. THOMSON.

FLOWERS are loved by all—in childhood, in youth, and in old age. We always welcome and adore the beautiful and fragrant blossoms, whether in the meadow, on the street, or in the sick chamber. Look at the little children as they merrily pick the buttercups and daisies from the neighboring fields or vacant lots and bring them home for "mamma" to put in water! The boys and girls at school are, of course, beyond the stage of buttercups and daisies, but watch them hunt for the trailing arbutus, the sweet scented honeysuckle, the delicately tinted laurel! Take notice of the rising generation in its teens and twenties—the beau with his boutonniere, the belle with her bouquet! And the benedict is just as susceptible as anybody else, for he cannot take a walk on Sunday without bringing home some beautiful floral trophy of the field with

* Veronica Dieffenbachii, Bentham, in D. C. Prod., 8, and in Hook. Fl. N. Zealand (1853 to 1855).—Fruticosa glaberrima; foliis lineari oblongis subobtusis, basi parum angustatis amplexicaulibus; racemis axillaribus folio longioribus glabris; sepalis lanceolatis acutis, corollæ tuoo breviori-bus; capsula ovoidea sub-acuta, calyce sub-triplo longiore. Chatham Islands.

which to decorate the table. Yea, even the close, shrewd, business man—the man whose mind is full of dollars and cents from Monday morning to Saturday night—sometimes gives way to the temptation of the little florist's store on the corner, and goes in to order that some geraniums, fuchsias, and a few other pot plants be sent to his home at once.

Then there are the "old folks," who have been changing physically and mentally for sixty years or more, and have formed many likes and dislikes. They are, as we say, set in their ways; but their love of flowers has never changed. Nothing apparently pleases the aged—the most highly honored and respected people of our nation—more than to sow seeds, raise flowers, and enjoy their presence and the pleasure they give to the younger generation. Truly, we are a nation of flower lovers. Why should it be otherwise? A love of flowers betokens civilization. Go where you will, you will always find that the more refined and cultured families can be distinguished by the flowers in the windows, gardens, or conservatories. The only trouble is that there is not enough provision made for saving the beautiful plants that annually go to waste in the fall of the year.

Nearly every well-to-do mechanic in the country towns and villages, and in the suburbs of our great

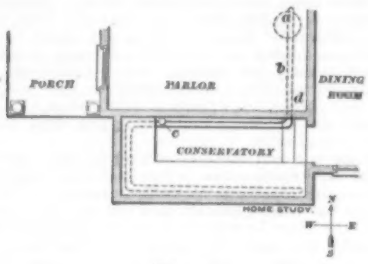


Fig. 1.

cities, has a flower patch, which buds and blooms all summer long. The plants are carefully nursed, and grow more beautiful every day, until some blasting, bitter wind comes along—betokening the approach of winter—and cuts them off in their prime. They never looked better than they did the day before, and now they are ruined forever; the result of a summer's labor are destroyed. Why this constant sowing of seeds in the spring, coaxing and nursing of tender plants during the summer, and ultimate destruction of the full-grown beauties in the fall every year? Why are not these flowers lifted and removed to a place of shelter, and kept for winter decoration and pleasure? Simply because the average family has no place to keep them, except in the living rooms of the house, and we all know the objections to keeping them there. Doctors tells us that it is unhealthy to keep flowers in the house, and we ourselves know that they must be sprinkled periodically and watered regularly to keep them alive. The products of combustion from oil and gas flames, and sulphurous gases from the stove or furnace, tend to kill the house plants during winter. Then, again, they become infected with insects and small vermin, and require to be fumigated occasionally; while last, but not least, they cannot usually get enough sunshine, and so become almost useless for outdoor planting in the spring.

What is wanted, then, is a more general use of houses or apartments especially constructed for the purpose of horticulture; and they must be made of glass. True, there are many such houses dotted all over this vast country, but they belong to the wealthy or to such of the general public whose business or hobby is horticulture.

Now, there is no reason why the pleasures of winter

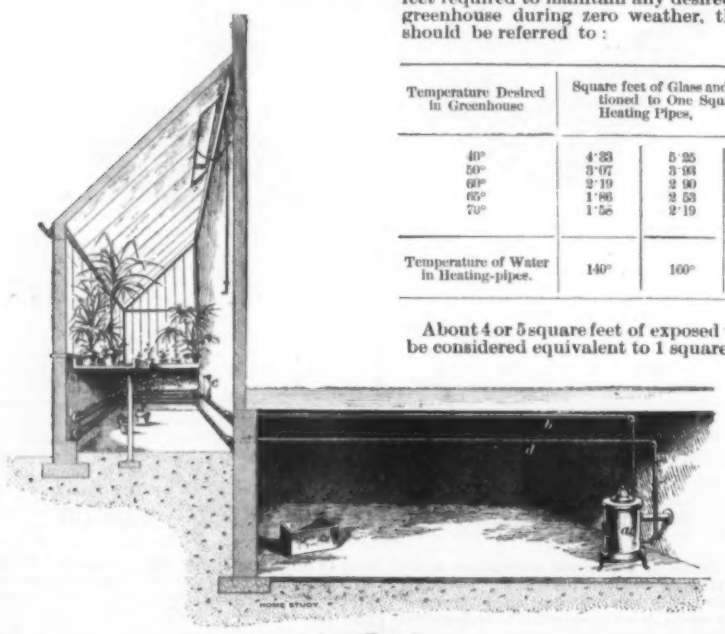


Fig. 2.

floral decorations should be confined to the wealthy; the industrious everyday mechanic can have the same thing, only on a smaller scale. The rich man can have his isolated greenhouses and conservatories, and no doubt can propagate and grow what he pleases, from mushrooms or forget-me-nots up to century plants or mammoth palms. He can have, and very often has, separate greenhouses for different purposes, such as carnation and chrysanthemum houses, vineries, palm houses, roseries, propagating houses, etc., all of which, however, do him no more good than a small general greenhouse does the family of the business or working man.

The cheapest and perhaps the most desirable form of greenhouse is a simple "lean-to" glass building, connected to the house—something like that of which a floor plan is shown in Fig. 1. However, we shall not, in this article, go into the design of the greenhouse itself, but shall consider the heating arrangements for a greenhouse of this type. If the dwelling house is heated with stoves or a furnace in the ordinary manner, the best, simplest, safest, and most economical heating system that can be used is a low-pressure hot water system. Such a system is essentially composed of a boiler, or water heater, a series of pipes, called a coil, in the greenhouse, two pipes, called respectively the flow and the return pipe, to connect the coil to the

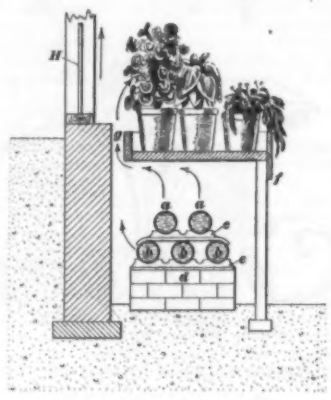


Fig. 3.

boiler, and an open tank or other vessel at the highest point of the system, called an expansion tank.

Fig. 2 shows the arrangement as it ought to be. A small cast-iron boiler, *a*, is set in the cellar near the chimney. A flow main, *b*, of 1¼ inch black-iron pipe, is run from the top tapping of the boiler to the expansion tank, *c*. A coil of four 1¼ inch pipe runs from the tank and under the flower pot benches. The lower end of the coil is continued full bore around the back of the greenhouse, and goes through the foundation wall into the cellar, and then connects to the bottom tapping of the heater, thus forming the return pipe, *d*, for the system. The floor pipe and all the other pipes must grade upward toward the tank with a pitch of not less than 1 inch in 10 feet, and all pipes must be supported, so that they will not sag, because if they are not properly graded, or if they sag, air bubbles will gather in the pipes and stop the circulation of the water. With the arrangement shown, all air bubbles will escape at the tank.

The reason why the tank is placed on the flow-pipe line, instead of on the return line, is to prevent the water from being blown out of the system if the heater should generate steam; also to allow a free escape of vapor, if necessary, by removing the loose cover of the tank during severely cold weather. This vapor will condense on the glass and freeze, thus forming a skin of ice, which not only closes the laps in the glass, but also forms a medium which helps the glass to prevent loss of heat by radiation and conduction.

Any man who is handy with tools can easily and very cheaply build a "lean-to" greenhouse for himself in the evenings, and if he has stocks and dies, he can readily install the heating system himself.

To determine the amount of pipe surface in square feet required to maintain any desired temperature in a greenhouse during zero weather, the following table should be referred to:

Temperature Desired in Greenhouse	Square feet of Glass and its Equivalent Proportioned to One Square Foot of Surface in Heating Pipes.			
40°	4·33	5·25	6·06	7·7
50°	3·07	3·93	4·76	5·7
60°	2·19	2·90	3·63	4·33
65°	1·86	2·53	3·22	3·84
70°	1·58	2·19	2·80	3·44
Temperature of Water in Heating-pipes.	140°	160°	180°	200°

About 4 or 5 square feet of exposed wall surface should be considered equivalent to 1 square foot of glass.

To find the size of heater required to properly heat a greenhouse having less than 500 square feet of glass—that is, about 150 square feet or less of hot-water radiation—divide the radiation by 10 to determine the proper area of flue-heating surface in square feet which the boiler should contain; or, if it is a direct-heating surface boiler, divide by 30 or 40.

To find the grate surface in square feet, divide the number of square feet of radiation by about 200; in no case, however, should the grate area be less than ¾ of a square foot.

To determine the capacity of the expansion tank above the pipe connections, divide the entire capacity of the heating system by 20.

The pipes should always be large—never less than 1¼ inches. In the best of greenhouses 4 inch pipes are used. Fig. 3 shows how 4 inch pipes are usually employed for heating a greenhouse. Five of them in all—two flow pipes, *a*, *a*, on top, and three return pipes, *b*, *b*, below—run the whole length of the benches, and are supported at intervals of about 8 or 10 feet, by brick piers, *d*. They are set in cast-iron chairs, *c*, and are staggered as shown, so that the air in flowing up between the pipes, *b*, *b*, must touch the upper pipes and thus become heated.

As the air near the glass is the coldest air in the house, it is advisable to keep the benches out from the wall a few inches, as at *g*. This allows the heated air from the pipes to flow freely up between the plants and the glass. If the benches are set close back to the wall, the plants next to the glass will surely freeze during very cold weather.

To prevent down draught at *g*, and, in fact, to compel the warm air to flow up *g*, in spite of the counteraction of a cold-air current at the glass, the face plate, or board, *f*, should hang about 4 or 6 inches below the bench planks.—For our engravings and the foregoing particulars we are indebted to Home Study Magazine, published at Scranton, Pa.

BABBITT METAL.

By C. Vickers.

"Genuine" babbitt is composed of a small quantity of copper added to tin and antimony. No lead is used, for the adjective "genuine" is applied especially to distinguish it from the cheaper grades containing lead.

There is considerable temptation to adulterate it with lead, owing to the difference in value of lead and tin; one pound of lead added to 100 of "genuine" makes a gain of about 18 cents. The character of the alloy would not be greatly altered, but when the purchaser pays for the best he certainly has a right to expect it. Fortunately, it is easy to detect such adulteration; take a piece and use it for a pencil, if it makes a mark, then it contains lead, as a small amount of lead added to tin causes the latter to mark paper. The following proportions may be used in making this alloy:

No. 1.

Copper	4 pounds.
Tin	8 "
Antimony	8 "

This forms the hardening, as it is called. First melt the copper, add the tin and afterward the antimony; remove from the fire and let cool down to a dull red heat, then add 16 pounds more tin to increase the fusibility of the hardening. This makes 32 pounds hardening, add this to 64 pounds more tin—the proportions of tin to hardening thus being two to one. The additional tin should be melted separately in a kettle or suitable vessel, and the hardening added either in ingot form or direct from the furnace; in the latter case be sure the tin is all melted, otherwise an accident might occur by the hot metal from the furnace falling on the damp end of a projecting ingot.

To prevent loss by oxidation, the contents of the kettle should not be heated much above the melting point. In cases where a cheaper composition is desirable the following can be recommended:

No. 2.

Genuine hardening	32 pounds.
Tin	64 "
Lead	93 "

This forms a good alloy. Another one is:

No. 3.

Hardening	16 pounds.
Tin	50 "
Antimony	20 "
Lead	80 "

In mixing this alloy first melt a portion of the lead, say 40 pounds, in the kettle, or in a crucible in the furnace, bring to a dull red heat, add the antimony, in small pieces; when melted, add the balance of lead. Do not attempt to melt the antimony without the lead bath, as it is a volatile metal and there would be a loss from oxidation.

In making all alloys containing hardening, a furnace is necessary to melt the copper. The following mixtures contain no copper, and are fairly good compositions:

No. 4.

For hardening take:

Lead	145 pounds.
Tin	40 "
Antimony	20 "

Melt 145 pounds lead and 40 pounds tin and add 52 pounds hardening.

No. 5.

For hardening:

Lead	48 pounds.
Antimony	36 "

Add this amount to 152 pounds lead. The hardening is used in this merely to form a bath for the antimony, and any portion of 200 pounds lead may be taken. This is cheap and soft.

Another cheap composition is formed as follows, and is known as "hard lead:"

No. 6.

Lead	80 pounds.
Antimony	20 "

Hard lead is better metal than No. 5. It is largely used for lining car journal bearings. It may be improved by the addition of tin, as in the following:

Hard lead	100 pounds.
Tin	100 "

This is given as an illustration. A great variety of alloys can be made by taking hard lead as a base and adding tin in varying quantities.—American Metal Worker.

ENGINEERING NOTES.

The Russian government has been impressed by the success of the American dynamite guns, and is considering the question of introducing them in the navy. Four ships will be provided with these guns experimentally, and they will be placed on other vessels if the experiment proves satisfactory.

Plans are being laid for the construction of an extensive underground street railway system in Berlin. According to reports the underground trackage is to be 25 miles, and the system is expected to cost about $20,000,000. The system is to be constructed for the municipality and is to remain its property.

The **American Machinist** gives the following as a handy rule for approximately estimating the weight of water in a pipe. Square the diameter in inches, and the result will be the weight of the water in pounds of each yard of pipe. The rule is, of course, also applicable to circular tanks or cisterns if vertical. Thus the weight of water in a cistern 10 feet diameter and with the water 8 feet deep will be $120^2 \times 2\frac{3}{4} = 34{,}340$ pounds, which result is about 5 per cent. less than the actual weight for water at 60° F., but 3 per cent. more than the weight at 212°.

A coaling station will be established by the Navy Department at the naval station, New London, Conn., and tenders have been asked for the work. The specifications call for the erection of coal pockets or sheds with a capacity for about 10,000 tons of bituminous coal on a basis of 45 cubic feet per ton. The plans contemplate the receipt of coal by rail over an extension now being built through the station, and also by water, suitable coal handling and conveying apparatus being provided for rapidly unloading or loading vessels or lighters. Only the most approved and substantial methods and construction will be used.

Some interesting tests to determine the durability of different protective coatings for metal when immersed in sea water have been made at the Brooklyn Navy Yard. The tests consisted in covering thin plates of steel and aluminum with different protective coatings, and afterward placing the plates in cages, immersing them in about 6 feet of sea water for a period of about 13 months. Altogether 113 plates were immersed, but only 72 could be recovered. On an examination of these plates the following conclusions were arrived at: 1. That, whatever pigment is used, a more durable coating for marine work results if varnish is used as the vehicle than if oil is used. 2. That a varnish coating or a pigment and varnish coating seems to endure sea water better when baked on than when merely air dried on. 3. That white zinc is probably acted upon as little as any pigment which was used in the tests. 4. That enamel coatings baked on at high temperature are apparently the most durable of any.

One of the many mountain railways now in process of construction in Switzerland ascends the Gornergrat, and some curious phenomena have been observed during the progress of the work. When the roadbed had been carried to a height of about nine thousand feet, an epidemic broke out among the workmen. Many of them went to the physician attached to the road, complaining of headache, palpitation of the heart, difficulty of breathing and fever; and the overseers noticed that the men who remained at work were easily fatigued, and did not accomplish so much in a day, by about one-third, as they did on the lower levels. The company's physician, Dr. Courton, sent the worst cases to Zermatt, where complete recovery took place in two or three days. Most of the men were Italians, from the province of Bologna, and the epidemic was pronounced to be simply "mountain fever;" but, as it was severe enough to interfere seriously with the enterprise, the Italians were replaced by men brought up in the Alps, and even these suffered to some extent.—American Architect.

Bids for smokeless powder for use on United States warships were received by the Navy Department on September 3, says Engineering News. The amount of explosive called for was 1,100,000 pounds, and the bids were made on two propositions: (1) that the government supply the alcohol and ether and (2) that the government supply the alcohol only. The bids were as follows:

	Proposition 1. Cts. per lb.	Proposition 2. Cts. per lb.
Dupont Powder Company, Wilmington, Del	79½	80
Giant Powder Company, San Francisco, Cal	90*	95*
Dittmar Powder Company, New York	80*	..
Lewis Nixon, Elizabethport, N. J.	90†	..
Laflin & Rand Powder Company	79½	80
California Powder Company	....	80

* For 250,000 pounds only. † For 100,000 pounds only.

The Bruges ship canal, now under construction in Belgium, was practically started in 1890, with the purpose of again connecting the town with the coast by a canal, with a port at Heyst. Work was actually commenced in 1896 by the Compagnie des Installations Maritimes de Bruges. The canal will be 6 miles long, 72½ feet wide at bottom, 229 feet at the water line and 26¼ feet deep. The harbor will be formed by a long mole, running out from shore in a curve of 4,000 to 6,000 feet radius, its end being parallel to the coast line and 2,788 feet distant at low water, and including an area of 370 acres. This jetty is solid to low water mark, and then open for 984 feet to facilitate the circulation of the tide and prevent deposits of silt and sand. From this opening to the end the jetty is being made of concrete blocks resting on iron caissons, each 82 feet long by 24 feet wide, and varying in height with depth of water. These caissons are built on shore and floated to their sites, and then sunk by concrete in a dredged bed. The upper part of the concrete caisson blocks, each weighing from 2,500 to 3,000 tons, will be 3 feet above low water, and on these will be placed 50-ton concrete blocks to a height of 28 feet above high water. The lock at the end of the ship canal is controlled by a caisson gate that can be slid into a recess at right angles to the canal in ten minutes, with electricity as a motive power. The work is to be completed in 1902, and the contract price is $7,793,805.

MISCELLANEOUS NOTES.

The whistling buoy which has long served to mark the entrance to the Golden Gate in San Francisco Harbor has lately been replaced by a lightship which was specially built for the purpose. Powerful electric lights are swung in ball-and-socket hinges, one at each masthead, 50 feet above the deck of the vessel, and in clear weather will be visible for a distance of 12 to 15 miles. The vessel is also fitted with a fog-horn and a large bell to aid in giving signals in thick weather.

Experimental posts for right-of-way fences are now being made of concrete, one part Portland cement to three parts of sand being the proportions of the mixture. The posts are about 4 by 5 inches in horizontal section, tapering slightly toward the top. They are cast in wooden moulds, with steel wires running from top to bottom through the interior, so as to hold the posts together in case of fracture or breakage. The weight is about 100 pounds, and a barrel of cement will make from 18 to 20 posts, at a cost of about 16 cents each. Corner posts are 8 by 8 inches in section, each costing 54 cents. During the process of moulding, fastenings are embedded into the concrete for attaching boards or barbed wire.

The widening of Elm Street, New York, recently exposed to view an iron water tank, which is said to be a hundred years old. The tank is about 35 feet in diameter and 15 feet high, and is composed of three courses of segmental iron castings, with flanged and bolted joints. The castings are about 2 feet 6 inches wide by 5 feet high, and are reinforced midway in their height by a web, the flanges at the joints also being reinforced by angle webs. Four iron hoops are placed around the tank, which rests on a masonry pier. The supply pipe is 10 inches in diameter, and is provided with a gate inclosed in a rectangular chamber formed by bolting together two flanged iron castings. The tank was erected by the Manhattan Company, and for a century is said to have been kept full of water in order to maintain the company's charter.

The Paris Exhibition of 1900 will have a very large representation from the United States, and thus far the space allotted to the various departments is given as follows by Mr. Ferdinand W. Peck, Commissioner-General for the United States:

	Square feet.
Agriculture and food products	30,000
Army and navy	3,300
Chemical industries	5,160
Education, instruments, practical sciences, and arts	11,470
Fine arts	(not yet known)
Forestry, hunting, and fisheries	3,300
Heating apparatus	4,500
Horticulture	(not yet known)
Machinery and electricity	50,000
Manufactures	25,000
Mines and mining	7,700
Textiles	13,000
Transportation and civil engineering	20,000
Total	163,430

The treatment of heaps of old mine tailings and refuse finds its parallel in the reclamation of coal from the great masses of anthracite buried in the mountains of coal dirt scattered all over the Schuylkill coal basin, says Industries and Iron. During the season just closed, 50,000 tons of good coal were reclaimed from the coal dirt near Kalmia colliery alone. Kalmia colliery is now abandoned as a coal mine, having been worked out. It was one of the best of the Reading Coal and Iron Company's western properties, and its product was vast in the many years of its operation. Now the company has turned its attention to reclaiming the coal in the drift mountains at the colliery. Suitable washing machines were put in, and quantities of first-class coal are being taken out of what was considered a mass of worthless dirt. So profitable is this business that several firms have gone into it in connection with the three Pennsylvania anthracite coal basins, and they are doing well.

We do seem a trifle behind date in this country in the introduction of horseless carriages, when the fact is noted that at the recent exhibition in Paris no fewer than 750 automobile vehicles, of the carriage type, were shown, and that of these 120 were of the light chaise type, says The Electrical Engineer. It may be questioned whether 150 carriages, all told, have yet been built here. This may not be altogether a misfortune, for there are indications that the manufacturers, who come chiefly from the bicycle field, are rapidly settling down to electricity to the exclusion of other motive powers; and that the latest types of carriages built here compare more than favorably with those put forward as the best examples of the automobile art as practiced abroad. We are told, as an illustration of the situation in France, that a recent parade along the streets of Paris left the thoroughfares in need of purification, while many of the spectators were driven away by the stench of the petroleum. France has given its efforts chiefly to oil carriages, but may not have much to show for its pains after all, when the automobile industry at last gets down to its permanent basis.—Some of our American petroleum carriages seem to leave nothing to be desired.—ED. S. A. S.

The largest raft of piles ever seen in this port arrived August 2 in tow of the steamer "Mackinaw," from Astoria, Ore., at the mouth of the Columbia River. The raft was of the cigar-shaped pattern, and the long tow was most successfully accomplished. In the big pile were 6,000,000 feet of lumber. The largest raft brought to San Francisco heretofore contained 5,000,000 feet of lumber. The "Mackinaw" dropped her tow at Arch Rock, and three tugboats took her place—one ahead of the raft and one on either side, while the tug "Monarch" brought up the rear in case of mishap. The raft and her escort attracted a great deal of attention as they proceeded up the bay toward Long Bridge. The big bundle of piles appeared to be in excellent condition, and hardly looked as if they had just arrived from a long ocean voyage. They were tied up at Long Bridge without mishap. Only one-half of the raft can be seen above water. The piles are bolted together by iron rods passing through them and cross beams, and the ends are bulkheaded, so as to prevent any disturbance by the action of the sea. In addition to these securities, heavy lashings are tied about the raft at intervals of every 10 feet. Some rough weather was encountered on the voyage, but the raft was not broken in the least.—San Francisco Examiner.

SELECTED FORMULÆ.

Show Globe Colors.—(Water Bottle.)

RED.

(1)	Distilled water	970 parts.
	Sulphuric acid	20 "
	Cochineal	6 "
	Bitartrate potassium	4 "
(2)	Distilled water	970 "
	Sulphuric acid	10 "
	Cochineal	8 "
	Alum	8 "
	Pure cream tartar	4 "
(3)	Distilled water	880 "
	Ammonia water	76 "
	Nitric acid	32 "
	Cobalt metal	8 "
	Alum	4 "
(4)	Carmine	3 to 5 grains.
	Chloride of tin	3 to 5 "
	Water of ammonia	1 drachm.

Water, enough to make 8 pints.

Dissolve the carmine in the water of ammonia; add the chloride of tin and water.

BLUE.

(1)	Distilled water	920 parts.
	Copper sulphate	30 "
	Alum	30 "
	Sulphuric acid	20 "
(2)	Distilled water	950 "
	Ammonia water	40 "
	Sulphate copper	10 "

Any desired shade can be obtained by varying the proportion of ammonia and copper salt.

(3)	Copper sulphate	160 grains.
	Solution potash	1 pint.
	Glycerin	¼ "
	Water	16 "

Dissolve copper sulphate in sufficient water, add to the solution potash, then glycerin, until complete solution results. Finally add the remainder of the water.

MULTICOLORS.

Here is a formula for the production of a so-called multicolored mixture for show globes. Seven different fluids are named, and you can select any three of them you wish, if that number is all you desire. The liquids and colors selected should be taken in the order in which they appear in the formula.

First, ascertain the capacity of the bottle and divide by seven, to find the volume of each solution or liquid to be employed. The fluids should, in the order named, be carefully poured down the side of the bottle, held in a slightly inclined position, or through a glass tube inserted into it.

First, one volume of sulphuric acid, C. P., tinted blue with indigo sulphate. Second, one volume of C. P. chloroform. Third, one volume of glycerin, slightly tinted with caramel. Fourth, one volume of castor oil, colored with alkanet root or alkannin. Fifth, one volume 40 per cent. alcohol, slightly tinted with green anilin. Sixth, one volume of cod liver oil, containing 1 per cent. oil turpentine. Seventh, one volume of 94 per cent. alcohol, slightly tinted with violet anilin.

The liquids are held in place by force of gravity, and alternate with fluids which are not miscible, so that the strata or layers are clearly defined and do not mingle by diffusion, as in the case when miscible liquids, as glycerin and water, are brought in direct contact with each other. Perhaps it is necessary to add that the colors suggested should be employed in quantities only sufficient to impart a pronounced tint to the fluids; too deep colors look dead and detract from the brilliancy of the combination.—Pharmaceutical Era.

Depilatory—Superfluous Hair.—The principal agents employed for the removal of superfluous hair are caustics, electricity, and the knife in minor surgical operations. Probably the best results, as a whole, are obtained from the use of the electric needle, and there are in nearly all large cities people who make a specialty of this form of treatment. For large blemishes, like hairy moles, etc., the advice of a competent physician should be sought, for frequently dangerous hemorrhages ensue from attempts to remove these blemishes. A very efficient caustic paste is the following, which is said to eat or dissolve the hair itself, but does not destroy the hair glands, and must be applied as frequently as the growth of the hair renders necessary:

Powdered quicklime	1 ounce.
Barium sulphide	1 "
Starch	1 "

The powder is first moistened with a little water and made into a paste and then applied. It acts in a few minutes, and is then removed by scraping with a paper knife or smaller blunt instrument. The skin is well washed with water and an emollient applied. Barium sulphide used in preparations of this character should be freshly prepared.

Here are some other formulas:

(1)	Barium sulphide	1 ounce.
	Zinc oxide	1 "
	Starch	2 "

Make into a paste with water at the time of using, spread over the part required, and remove at the end of five or ten minutes.

(2)	Sodium sulphide	6 drachms.
	Powdered quicklime	3 ounces.
	Starch	2 "
	Powdered orris	1 "

A depilatory long used in the Orient consists of 1 part orpiment and 6 parts of lime slaked to a powder. The ingredients are intimately mixed by passing them through a sieve. For use, it is made into a paste with water, similarly to that given above, and applied. It is very energetic, and its use is not advised.—Pharmaceutical Era.

THE DIVISION OF CLOCK DIALS.

The primitive division of the dials of clepsydras and mechanical clocks seems to have been most generally into 24 hours, although it was sometimes into 12.

In the fifteenth century, in the belfry clocks, and, in the sixteenth, in all kinds of clocks, the division of the dial was into 24 hours, and such division was in use up to the last century, although it was not common.

In the literary memoirs of the Academie des Inscriptions for 1753 there is a paper entitled "Dissertations sur J. de Dondis et à cette occasion sur les anciennes horloges" (by Falconet). In this we read:

"Pontus de Thiard (1521–1603), a poet and bishop of Chalons, distinguishes the clocks that marked (and perhaps struck) 24 hours from those that marked but 12. He calls the first entire and the others half-clocks."

There were several manners of arranging the 24

Fig. 1.—ITALIAN CLOCK OF THE BEGINNING OF THE SEVENTEENTH CENTURY.

Fig. 2.—DIAL, FROM AN ENGRAVING BY DITTERLIN.

Fig. 4.—DIAL, FROM AN OLD PRINT.

hours upon the dials, and of these we shall mention a few.

In the belfry clocks of the fifteenth and sixteenth centuries, the 24 hours were marked upon the same disk in two periods of 1 to 12. This was almost the only arrangement then. The cathedral of Chartres offers two very fine specimens of it, one in the dial of the choir tower and the other in the dial placed in the small edifice constructed especially for the clock outside of the building in 1520 (Fig. 3). This dial is particularly remarkable because of the sharpness of its details. Others thus divided are found at Wimborne and Glastonbury, in England; at Venice, in Italy; at Berne, in Switzerland, etc.

Despite our researches, we have been unable to find any house clocks of the fifteenth century except those having the 12 hour division.

In the table and mantel clocks of the sixteenth century, on the contrary, there exist many 24 hour arrangements of the dials; in the first place, the one just mentioned in connection with belfry clocks, that is to say, two periods of 1 to 12 or 1 to 24 upon the same disk; and, in the second, two periods of 1 to 12 or 1 to 24 upon two concentric disks.

The idea of several disks is explained by the size of the dials of these clocks, which were often so small that the reading of the hours was rendered difficult. Each of these disks frequently had the hours engraved in different characters. For example, one was in Arabic and the other in Roman figures; or, if they were of the same nature, their aspect differed. In one the engraving was fine, while in the other all the lines were heavy.

These concentric disks produced a decorative effect of a certain richness, especially when they were accompanied with a third and sometimes even a fourth concentric with the first (Fig. 4). These disks served either for alarms or for giving the phases of the moon.

In a tapestry design by Raphael in the Museum of the Louvre we have found a 24 hour dial the characters of which were arranged radiatingly in so many sectors. The signs of the zodiac in the dial of the choir tower of the cathedral of Chartres were thus placed.

The watches of the sixteenth century sometimes had the 24 hour division. The collection of Prince Soltikoff included, among others, one that is represented in the catalogue of the sale. The dial of this superb piece is provided with two disks with two periods, one of 1 to 13 and the other of 13 to 24, each engraved in different characters.

To make the characters easy to read has been the aim of clock makers of all times. So as long ago as the thirteenth century, the epoch at which the dials of clepsydras were in most cases divided into 24 hours, 6 hour dials were made. We read in Littré (Vol. III., p. 570): "Li jors a 4 quadrans, li quadran 6 eures, li eure 4 points, les points 10 moments," etc.

This tradition has always continued, and in Italy, where the division into 24 hours has persisted, the 6 hours with the corresponding striking trains were employed in clocks of the sixteenth century. It should be remarked that it must have been much more embarrassing to count 24 hours than to read the figure 24 directly upon the dial.

Martinelli, in his treatise upon elementary clocks (Venice, 1663), calls them "6 hour clocks after the manner of Rome." There was certainly here an exaggeration, but the reading of the dial was easy, and relatively to the striking train confusion was impossible, since one stroke at 7 o'clock in the morning or at 7 in the evening could not indicate 1 o'clock in the morning or 1 in the evening, seeing the difference in the time.

The same was the case with the indication of the hour hand. Such division of dials is little known, and specimens of it are rare.

As long ago as the fifteenth century another method of rendering dials legible was devised. There was inscribed in the disk, divided into 12 hours, a second and concentric one upon which were marked the quarters (Fig. 2). This method was employed up to the seventeenth century. By this means, the minute hand, which in our present clocks is the longer, was then the shorter one, since the hours were beyond the minutes, or rather the quarters, the minute division having been much neglected in the fifteenth century.

In many cases in the sixteenth and seventeenth centuries there were two separate dials, one for the hours and one for the quarters.

The type that we reproduce (Fig. 1) is peculiar in that it shows us in the same clock of the beginning of the seventeenth century the three arrangements of dials that we have just mentioned; that is to say, the 12 hour, 6 hour, and quarter hour dial. We evidently find ourselves here in the presence of a caprice of the kind then in vogue, and this makes it all the more curious.

Upon the whole, the fact must be recognized that, for the proper reading of a dial, although the 6 hour division is inadequate, the 24 hour one is exaggerated, at least for the small diameters of the dials of mantel clocks and watches, and that for such pieces, despite a certain logic relative to the day of 24 hours, the 12 hour division is the most practical.—La Nature.

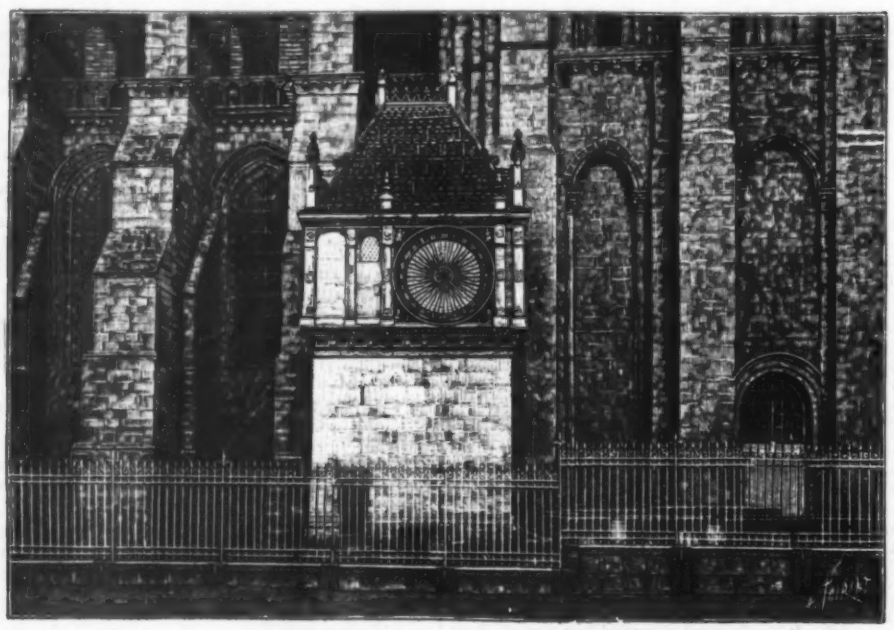


Fig. 3.—CLOCK OF THE CATHEDRAL OF CHARTRES.

PAPYRISTITE.

Since taking charge of this consulate, I have at different times received communications from the United States inquiring about a certain artificial material called papyrolith, in regard to which my predecessor sent a report to the department.*

I have made diligent inquiries, seen samples of the material, and now, for the benefit of the public, beg to report as follows:

A new artificial stone or moss has recently made its appearance on the builder's technical market, called papyristite, on account of the ingredients entering into its composition, principal among which is purified paper pulp obtained from waste paper.

Papyristite is an improvement on papyrolith, both having been invented by Mr. Fr. Gehre, a civil engineer of Zurich. It can be used in various ways, but is specially intended to serve as a solid, impermeable, and jointless roof or floor, which, when once laid, will present a smooth surface as if made in one continuous layer. This new material, I am told, is a non-conductor of heat, cold, or sound, and, although as hard as stone, has a soft, linoleum-like feeling to the foot, and is noiseless.

Accumulations of dust, vermin, or fungi are impossible, there being no grooves or joints. The weight is much less than that of stone or cement.

One hundred kilogrammes (220 pounds) of this preparation in a powdered form, when mixed for use and spread to a thickness of 10 millimeters (0·3940 inch), will cover a surface of 8½ square meters (91½ square feet).

The ingredients for the manufacture of papyristite are obtainable in the United States, and the cost is exceedingly low.

No machinery is necessary to prepare the compound, although, to save labor, where great quantities are to be used, an ordinary press can be utilized to advantage. It can be moulded or spread in any desirable form or shape, as in the case with cement. The mixing is done on the spot where it is wanted, and it is transported, like cement, in barrels or sacks.

The drying or hardening process is effected in twenty-four hours after spreading, and then, if desired, it can be polished to a high gloss. The inventor's numerous experiments have given good results, and his persistent efforts seem at last to have been crowned with success.

Taking the opinion of prominent architects who have experimented with this new material, there seems to be no doubt that a valuable building material has been discovered, which can be utilized in many ways. It is as hard as marble, and is practically indestructible, yet it is elastic and possesses all of the qualities mentioned above.

It can be cut, sawed, and bored; given any desirable tint, and made to look like marble or mosaic.

For roofing purposes it is also valuable. A light iron framework has been invented by Mr. Gehre, and the material is put on in the form partly of plates and partly of mortar, which, when united, produce a smooth, continuous surface. It is adapted to cold as well as to tropical regions, and its stone-like qualities protect it against mice or other vermin. Trials of this material have been made in Russia and Brazil, and the reports received are very encouraging. It will probably be widely used in the near future.

The material, once laid, will never contract or warp; and where the instructions for the mixing process are well carried out the results cannot fail to prove all the inventor claims for his product. It is elastic, light, and inexpensive in production.

* See Consular Reports No. 198 (March, 1897), p. 343.

For schoolrooms, public halls, corridors, bathrooms (both floor and walls), terraces, barns, poultry yards, etc., no better, cleaner, and healthier material can be found; and, as a non-absorbent of moisture, filth, or other unhealthy substances, it is no doubt without equal as a building material.

Patents for the process and material, as well as for the roof frame necessary thereto, have been applied for in the United States.

The inventor will furnish, upon application, samples of the finished material to parties who pay express charges, or will sell the raw ingredients to the party wishing to experiment at 18 marks ($4.50) per 100 kilometers (220 pounds), free on board cars at Zurich.

For other information, address Papyristite Company, Post Fach 10469, Zurich, Switzerland.

A. LIEBERKNECHT, Consul.

Zurich, June 22, 1898.

—In United States Consular Reports.

USE OF BAMBOO AMONG THE ANNAMITES.

COLONISTS and officials starting for Indo-China often say that they purpose carrying civilization to this sultry country; but how many of those who had an idea that they were going to furnish the Annamite population with their mite of civilizing influence have not, on the contrary, borrowed its processes of work, which are exactly adapted to the material resources and needs of production?

Thus, for example, the Annamites, without the aid of our complicated machines, the cost of which would represent a fortune to them, use for hydraulic and mechanical work the bamboo alone, which they employ also for all domestic, agricultural and industrial purposes. Of the house ("cainha") the walls, partitions, the framing of the roof and the furniture are of bamboo.

Among the industries, we may mention at random the rice alcohol distilleries, in which bamboo pipes are luted with clay to bamboo receivers. The frames of the weaver and rope maker, the apparatus of the fisherman and cooper, the spear of the warrior and the sonorous instrument of the watchman are of bamboo; and it is with the cortex of this valuable grass that the natives manufacture paper, weave boats, baskets, and mats, and make rope.

Its young stalks constitute a choice article of food to the people and its leaves are eagerly sought by horses and cattle.

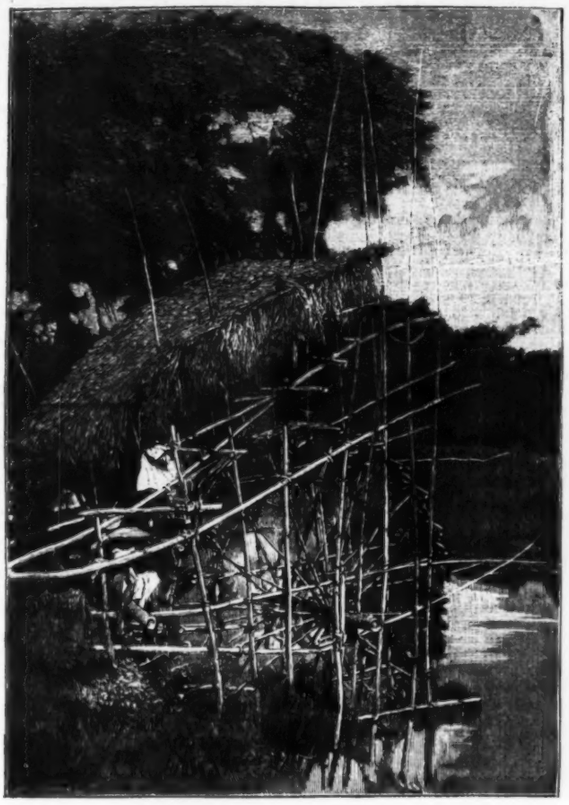
One of the most remarkable uses to which the bamboo is put is in the construction of norias. During the dry season, when the water is low in the rivers, and but a thin stream is flowing at the bottom of the channel, the Annamites raise the water of such stream by means of norias, and, through aqueducts, distribute it among their parched fields.

The accompanying figures, from L'Illustration, represent norias installed upon the Song Tra-Cuk, in the province of Quang-Ngay.

At a short distance up stream from the place selected for establishing a noria, small dams are constructed by planting bamboo rods in the bed of the river so as to constitute a jetty that increases the course of the current for just the time necessary to accelerate the motion of the noria.

A passage is left free in the center of the river so that navigation shall not be interrupted. The installation of the dam is completed by a lantern, which is lighted at night.

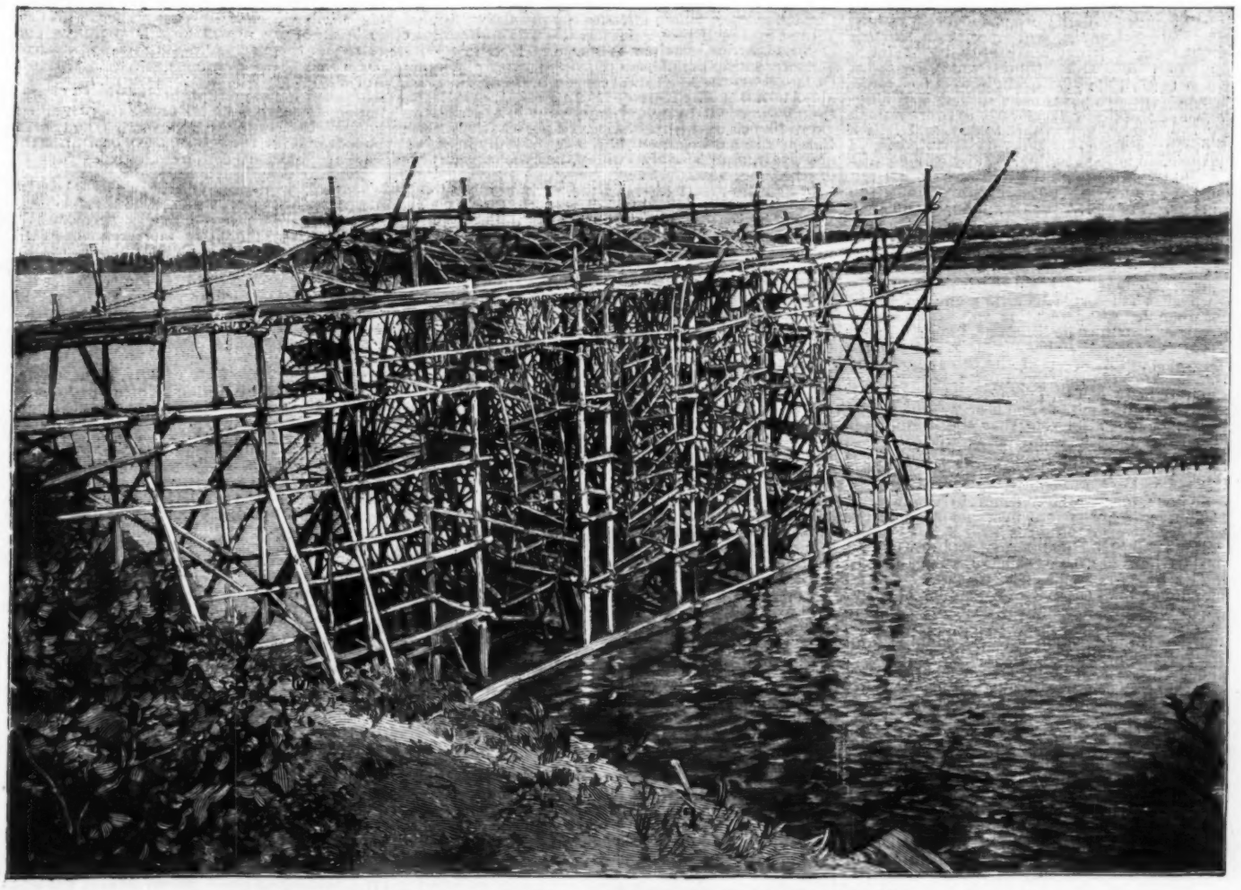
The principal elements of the noria are two wheels each thirty feet in diameter and about three feet apart. These are connected with each other by twenty-six paddles that alternate with twenty-six bamboo tubes arranged obliquely.



A SMALL BAMBOO NORIA.

The paddles are struck by the current and cause the noria to move slowly. Each tube, on passing into the water, becomes full and then rises; but when it begins its descending half-revolution, its position is inverted and it allows its contents to escape into a woven bamboo conduit which communicates with a system of aqueducts.

The wheels make one revolution every forty seconds, and each tube in its passage empties two quarts of water—say seventy-eight quarts a minute for each noria. Sometimes there is met with an installation of eight norias that discharge in this way one hundred and fifty gallons a minute. One coolie suffices to watch over and keep them in order. In the small arroyos, where there is hardly any current, the natives construct smaller norias in which the paddles are replaced by steps or rounds which one or more coolies tread in order to



BAMBOO NORIAS UPON THE SONG TRA-CUK (ANNAM).

revolve the wheel by means of their weight. The wealthier natives fix to the noria a huge hard wood pinion which receives the motion of a horizontal wheel revolved by a buffalo.

Those who have not the means to construct a noria make a ditch in the bank and at the end of this dig a reservoir. A couple of natives draw water from the river and pour it into the ditch by manipulating a woven bamboo bucket fixed to the middle of a rope of which they grasp the extremities. A similar installation takes the water from the reservoir and empties it into the aqueduct.

INAUGURAL ADDRESS BY SIR WILLIAM CROOKES, F.R.S., V.P.C.S., PRESIDENT OF THE BRITISH ASSOCIATION.

FOR the third time in its history the British Association meets in your city of Bristol. The first meeting was held under the presidency of the Marquis of Lansdowne in 1836, the second under the presidency of Sir John Hawkshaw in 1875. Formerly the president unrolled to the meeting a panorama of the year's progress in physical and biological sciences. To-day the president usually restricts himself to specialties connected with his own work, or deals with questions which for the time are uppermost. To be president of the British Association is undoubtedly a great honor. It is also a great opportunity and a great responsibility; for I know that, on the wings of the press, my words, be they worthy or not, will be carried to all points of the compass. I propose first to deal with the important question of the supply of bread to the inhabitants of these islands, then to touch on subjects to which my life work has been more or less devoted. I shall not attempt any general survey of the sciences; these, so far as the progress in them demands attention, will be more fitly brought before you in the different sections, either in the addresses of the presidents or in communications from members.

Before proceeding with my address I wish to refer to the severe loss the British Association has sustained in the death of Lord Playfair. With Sir John Lubbock and Lord Rayleigh, Lord Playfair was one of the permanent trustees of our association, and for many years he was present at our meetings. It would be difficult to overrate his loss to British science. Lord Playfair's well matured and accurate judgment, his scientific knowledge, and his happy gift of clothing weighty thoughts in persuasive language, made his presence acceptable, whether in the council chamber, in departmental inquiries, or at light social gatherings, where, by the singular laws of modern society, momentous announcements are sometimes first given to the world. Lord Playfair (then Sir Lyon Playfair) was president of the British Association at Aberdeen in 1885; his address on that occasion will long be remembered as a model of profound learning and luminous exposition.

And now I owe a sort of an apology to this brilliant audience. I must ask you to bear with me for ten minutes, for I am afraid what I now have to say will prove somewhat dull. I ought to propitiate you, for to tell the truth, I am bound to bore you with figures. Statistics are rarely attractive to a listening audience; but they are necessary evils, and those of this evening are unusually doleful. Nevertheless, when we have proceeded a little way on our journey, I hope you will see that the river of figures is not hopelessly dreary. The stream leads into an almost unexplored region, and to the right and left we see channels opening out, all worthy of exploration, and promising a rich reward to the statistic explorer who will trace them to their source—a harvest, as Huxley expresses it, "immediately convertible into those things which the most sordidly practical of men will admit to have value, namely, money and life." My chief subject is of interest to the whole world—to every race, to every human being. It is of urgent importance to-day, and it is a life and death question for generations to come. I mean the question of food supply. Many of my statements you may think are of the alarmist order; certainly they are depressing, but they are founded on stubborn facts. They show that England and all civilized nations stand in deadly peril of not having enough to eat. As mouths multiply, food resources dwindle. Land is a limited quantity, and the land that will grow wheat is absolutely dependent on difficult and capricious natural phenomena. I am constrained to show that our wheat producing soil is totally unequal to the strain put upon it. After wearying you with a survey of the universal dearth to be expected, I hope to point a way out of the colossal dilemma. It is the chemist who must come to the rescue of the threatened communities. It is through the laboratory that starvation may ultimately be turned into plenty.

The food supply of the kingdom is of peculiar interest to this meeting, considering that the grain trade has always been, and still is, an important feature in the imports of Bristol. The imports of grain to this city amount to about 25,000,000 bushels per annum—8,000,000 of which consist of wheat.

What are our home requirements in the way of wheat? The consumption of wheat per head of the population (unit consumption) is over 6 bushels per annum; and taking the population at 40,000,000, we require no less than 240,000,000 bushels of wheat, increasing annually by 2,000,000 bushels, to supply the increase of population. Of the total amount of wheat consumed in the United Kingdom, we grow 25 and import 75 per cent.

So important is the question of wheat supply that it has attracted the attention of Parliament, and the question of national granaries has been mooted. It is certain that, in case of war with any of the great powers, wheat would be contraband, as if it were cannon or powder, liable to capture even under a neutral flag. We must therefore accept the situation and treat wheat as munitions of war, and grow, accumulate, or store it as such. It has been shown that at the best our stock of wheat and flour amounts only to 64,000,000 bushels—fourteen weeks' supply—while last April our stock was equal to only 10,000,000 bushels, the smallest ever recorded by "Beerbohm" for the period of the season. Similarly, the stocks held in Europe, the United States, and Canada, called "the world's visible supply," amounted to only 54,000,000 bushels, or 10,000,000 bushels less than last year's sum total, and nearly 82,000,000 less than that of 1893 or 1894 at the corresponding period. To arrest this impending danger, it has been proposed that an amount of 64,000,000 bushels of wheat should be purchased by the State and stored in national granaries, not to be opened, except to remedy deterioration of grain, or in view of national disaster rendering starvation imminent. This 64,000,000 bushels would add another fourteen weeks' life to the population; assuming that the ordinary stock had not been drawn on, the wheat in the country would only then be enough to feed the population for twenty-eight weeks.

I do not venture to speak authoritatively on national granaries. The subject has been discussed in the daily press, and the recently published report from the Agricultural Committee on National Wheat Stores brings together all the arguments in favor of this important scheme, together with the difficulties to be faced if it be carried out with necessary completeness.

More hopeful, although difficult and costly, would be the alternative of growing most, if not all, our own wheat supply here at home in the British Isles. The average yield over the United Kingdom last year was 29·07 bushels per acre, the average for the last eleven years being 29·46. For twelve months we need 240,000,000 bushels of wheat, requiring about 8,250,000 acres of good wheat growing land, or nearly 13,000 square miles, increasing at the rate of 100 square miles per annum, to render us self-supporting as to bread food. This area is about one-fourth the size of England.

A total area of land in the United Kingdom equal to a plot 110 miles square, of quality and climate sufficient to grow wheat to the extent of 29 bushels per acre, does not seem a hopeless demand.* It is doubtful, however, if this amount of land could be kept under wheat, and the necessary expense of high farming faced, except under the imperious pressure of impending starvation, or the stimulus of a national subsidy or permanent high prices. Certainly these 13,000 square miles would not be available under ordinary economic conditions, for much, perhaps all, the land now under barley and oats would not be suitable for wheat. In any case, owing to our cold, damp climate and capricious weather, the wheat crop is hazardous, and for the present our annual deficit of 180,000,000 bushels must be imported. A permanently higher price for wheat is, I fear, a calamity that ere long must be faced. At enhanced prices, land now under wheat will be better farmed, and therefore will yield better, thus giving increased production without increased area.

The burning question of to-day is, What can the United Kingdom do to be reasonably safe from starvation in presence of two successive failures of the world's wheat harvest, or against a hostile combination of European nations? We eagerly spend millions to protect our coasts and commerce; and millions more on ships, explosives, guns, and men; but we omit to take necessary precautions to supply ourselves with the very first and supremely important munition of war—food.

To take up the question of food supply in its scientific aspect, I must not confine myself exclusively to our own national requirements. The problem is not restricted to the British Isles—the bread eaters of the whole world share the perilous prospect—and I do not think it out of place if on this occasion I ask you to take with me a wide, general survey of the wheat supply of the whole world.

Wheat is the most sustaining food grain of the great Caucasian race, which includes the peoples of Europe, United States, British America, the white inhabitants of South Africa, Australasia, parts of South America, and the white population of the European colonies. Of late years the individual consumption of wheat has almost universally increased. In Scandinavia it has risen 100 per cent. in twenty-five years; in Austria-Hungary, 80 per cent.; in France, 20 per cent.; while in Belgium it has increased 50 per cent. Only in Russia and Italy, and possibly Turkey, has the consumption of wheat per head declined.

In 1871 the bread eaters of the world numbered 371,000,000. In 1881 the numbers rose to 416,000,000; in 1891 to 472,600,000, and at the present time they number 516,500,000. The augmentation of the world's bread eating population in a geometrical ratio is evidenced by the fact that the yearly aggregates grow progressively larger. In the early seventies they rose 4,300,000 per annum, while in the eighties they increased by more than 6,000,000 per annum, necessitating annual additions to the bread supply nearly one-half greater than sufficed twenty-five years ago.

How much wheat will be required to supply all these hungry mouths with bread? At the present moment it is not possible to get accurate estimates of this year's wheat crops of the world, but an adequate idea may be gained from the realized crops of some countries and the promise of others. To supply 516,500,000 bread eaters, if each bread eating unit is to have his usual ration, will require a total of 2,324,000,000 bushels for seed and food. What are our prospects of obtaining this amount?

According to the best authorities, the total supplies from the 1897-98 harvest are 1,921,000,000 bushels. The requirements of the 516,500,000 bread eaters for seed and food are 2,324,000,000 bushels; there is thus a deficit of 403,000,000 bushels, which has not been urgently apparent owing to a surplus of 300,000,000 bushels carried over from the last harvest. Respecting the prospects of the harvest year just beginning, it must be borne in mind that there are no remainders to bring over from last harvest. We start with a deficit of 103,000,000 bushels and have 6,500,000 more mouths to feed. It follows, therefore, that one-sixth of the required bread will be lacking unless larger drafts than now seem possible can be made upon early produce from the next harvest.

The majority of the wheat crops between 1882 and 1896 were in excess of current needs, and thus considerable reserves of wheat were available for supplementing small deficits from the four deficient harvests. But bread eaters have almost eaten up the reserves of wheat, and the 1897 harvest being under average, the conditions become serious. That scarcity and high prices have not prevailed in recent years is due to the fact that since 1889 we have had seven world crops of wheat and six of rye abundantly in excess of the average. These generous crops increased accumulations to such an extent as to obscure the fact that the harvests of 1895 and 1896 were each much below current requirements. Practically speaking, reserves are now exhausted, and bread eaters must be fed from current harvests—accumulations under present conditions being almost impossible. This is obvious from the fact that a harvest equal to that of 1894 (the greatest crop on record, both in acre yield and in the aggregate) would yield less than current needs.

It is clear we are confronted with a colossal problem that must tax the wits of the wisest. When the bread eaters have exhausted all possible supplies from the 1897-98 harvest, there will be a deficit of 103,000,000 bushels of wheat, with no substitution possible unless Europeans can be induced to eat Indian corn or rye bread. Up to recent years the growth of wheat has kept pace with demands. As wheat eaters increased, the acreage under wheat expanded. The world has become so familiarized with the orderly sequence of demand and supply, so accustomed to look upon the vast plains of other wheat growing countries as inexhaustible granaries, that, in a light hearted way, it is taken for granted that so many million additional acres can be added year after year to the wheat growing area of the world. We forget that the wheat growing area is of strictly limited extent, and that a few million acres regularly absorbed soon mount to a formidable number.

The present position being so gloomy, let us consider future prospects. What are the capabilities as regards available area, economic conditions, and acreage yield of the wheat growing countries from whence we now draw our supply?

For the last thirty years the United States have been the dominant factor in the foreign supply of wheat, exporting no less than 145,000,000 bushels. This shows how the bread eating world has depended, and still depends, on the United States for the means of subsistence. The entire world's contributions to the food bearing area have averaged but 4,000,000 acres yearly since 1869. It is scarcely possible that such an average, under existing conditions, can be doubled for the coming twenty-five years. Almost yearly, since 1885, additions to the wheat growing area have diminished, while the requirements of the increasing population of the States have advanced, so that the needed American supplies have been drawn from the acreage hitherto used for exportation. Practically there remains no uncultivated prairie land in the United States suitable for wheat growing. The virgin land has been rapidly absorbed, until at present there is no land left for wheat without reducing the area for maize, hay, and other necessary crops.

It is almost certain that within a generation the ever increasing population of the United States will consume all the wheat grown within its borders, and will be driven to import, and, like ourselves, will scramble for a lion's share of the wheat crop of the world. This being the outlook, exports of wheat from the United States are only of present interest, and will gradually diminish to a vanishing point. The inquiry may be restricted to such countries as probably will continue to feed bread eaters who annually derive a considerable part of their wheat from extraneous sources.

But if the United States, which grow about one-fifth of the world's wheat, and contribute one-third of all wheat exportations, are even now dropping out of the race, and likely soon to enter the list of wheat importing countries, what prospect is there that other wheat growing countries will be able to fill the gap, and by enlarging their acreage under wheat, replace the supply which the States have so long contributed to the world's food? The withdrawal of 145,000,000 bushels will cause a serious gap in the food supply of wheat importing countries, and unless this deficit can be met by increased supplies from other countries, there will be a dearth for the rest of the world after the British Isles are sufficiently supplied.

Next to the United States, Russia is the greatest wheat exporter, supplying nearly 95,000,000 bushels.

Although Russia at present exports so lavishly, this excess is merely provisional and precarious. The Russian peasant population increases more rapidly than any other in Europe. The yield per acre over European Russia is meager—not more than 8·6 bushels to the acre—while some authorities consider it as low as 4·6 bushels. The cost of production is low—lower even than on the virgin soils of the United States. The development of the fertile though somewhat overrated "black earth," which extends across the southern portion of the empire and beyond the Ural Mountains into Siberia, progresses rapidly. But, as we have indicated, the consumption of bread in Russia has been reduced to danger point. The peasants starve and fall victims to "hunger typhus," while the wheat growers export grain that ought to be consumed at home.

Considering Siberia as a wheat grower, climate is the first consideration. Summers are short—as they are in all regions with continental climates north of the 45th parallel—and the ripening of wheat requires a temperature averaging at least 65° Fah. for fifty-five to sixty-five days. As all Siberia lies north of the summer isotherm of 65°, it follows that such region is ill adapted to wheat culture unless some compensating climatic condition exists. As a fact, the conditions are exceptionally unfavorable in all but very limited districts in the two westernmost governments. The cultivable lands of Western Siberia adapted to grain bearing neither equal in extent nor in potential productive powers those of Iowa, Minnesota, and Nebraska. There are limited tracts of fair productiveness in Central Siberia and in the valleys of the southern affluents of the Amoor, but these are only just capable of supporting a meager population.

Prince Hilkoff, Russian Minister of Ways and Communications, declared in 1896 that "Siberia never had produced, and never would produce, wheat and rye enough to feed the Siberian population." And, a year later, Prince Kropotkin backed the statement as substantially correct.

Those who attended the meeting of the British Association last year in Canada must have been struck with the extent and marvelous capacity of the fertile plains of Manitoba and the Northwest Provinces. Here were to be seen 1,290,000 acres of fine wheat growing land yielding 18,261,950 bushels, one-fifth of which

*The total area of the United Kingdom is 120,979 square miles; therefore the required land is about a tenth part of the total.

comes to hungry England. Expectations have been cherished that the Canadian Northwest would easily supply the world with wheat, and exaggerated estimates are drawn as to the amount of surplus land on which wheat can be grown. Thus far performance has lagged behind promise, the wheat bearing area of all Canada having increased less than 500,000 acres since 1884, while the exports have not increased in greater proportion. As the wheat area of Manitoba and the Northwest has increased, the wheat area of Ontario and the Eastern Provinces has decreased, the added acres being little more than sufficient to meet the growing requirements of population. We have seen calculations showing that Canada contains 500,000,000 acres of profitable wheat land. The impossibility of such an estimate ever being fulfilled will be apparent when it is remembered that the whole area employed in both temperate zones for growing all the staple food crops is not more than 580,000,000 acres, and that in no country has more than 9 per cent. of the area been devoted to wheat culture.

The fertility of the Northwest Provinces of the Dominion is due to an exceptional and curious circumstance. In winter the ground freezes to a considerable depth. Wheat is grown in the spring, generally April, when the frozen ground has been thawed to a depth of three inches. Under the hot sun of the short summer the grain sprouts with surprising rapidity, partly because the roots are supplied with water from the thawing depths. The summer is too short to thaw the ground thoroughly, and gate posts or other dead wood extracted in autumn are found still frozen at their lower ends.

Australasia as a potential contributor to the world's supply of wheat affords another fertile field for speculation. Climatic conditions limit the Australian wheat area to a small portion of the southern littoral belt. Prof. Shelton considers there are still fifty million acres in Queensland suitable for wheat, but hitherto it has never had more than 150,000 acres under cultivation. Crops in former days were liable to rust, but since the rust in wheat conferences and the dissemination of instruction to farmers, rust no longer has any terrors. I am informed by the Queensland Department of Agriculture that of late years they practically have bred wheat vigorous enough to resist this plague. For the second season in succession the wheat crop last year was destroyed over large areas in Victoria; and in South Australia the harvest averaged not more than about 3¾ bushels per acre after meeting Colonial requirements for food and seed, leaving only 634,000 bushels for export. In most other districts the yield falls to such an extent as to cause Europeans to wonder why the pursuit of wheat raising is continued.

New Zealand has a moist climate resembling that of Central and Southern England, while South Australia is semi-arid, resembling Western Kansas. Only two countries in the world yield as much wheat per acre as New Zealand—these are Denmark and the United Kingdom. Notwithstanding the great yield of wheat, due to an equable climate, New Zealand finds fruit and dairy farming still more profitable. The climatic conditions favorable to wheat are also conducive to luxuriant growths of nutritious grasses. Thus the New Zealander ships his butter more than half-way round the world, and competes successfully with Western Europe.

During the last twenty-seven years the Austro-Hungarian population has increased 21·8 per cent. as against an increase of 54·6 per cent. in the acreage of wheat. Notwithstanding this disparity in the rates of increase, exports have practically ceased by reason of an advance of nearly 80 per cent. in unit consumption. There can be little doubt that Austria-Hungary is about to enter the ranks of importing nations, although in Hungary a considerable area of wheat land remains to be brought under cultivation.

Roumania is an important wheat-growing country. In 1896 it produced 69,000,000 bushels, and exported 34,000,000 bushels. It has a considerable amount of surplus land which can be used for wheat, although for many years the wheat area is not likely to exceed home requirements.

France comes next to the United States as a producer of wheat; but for our purpose she counts but little, being dependent on supplies from abroad for an average quantity of 14 per cent. of her own production. There is practically no spare land in France that can be put under wheat in sufficient quantity to enable her to do more than provide for increase of population.

Germany is a gigantic importer of wheat, her imports rising 700 per cent. in the last twenty-five years, and now averaging 35,000,000 bushels. Other nations of Europe, also importers, do not require detailed mention, as under no conceivable conditions would they be able to do more than supply wheat for the increasing requirements of their local population, and instead of replenishing, would probably diminish the world's stores.

The prospective supply of wheat from Argentina and Uruguay has been greatly overrated. The agricultural area includes less than 100,000,000 acres of good, bad and indifferent land, much of which is best adapted for pastoral purposes. There is no prospect of Argentina ever being able to devote more than 30,000,000 acres to wheat; the present wheat area is about 6,000,000 acres, an area that may be doubled in the next twelve years. But the whole arable region is subject to great climatic vicissitudes, and to frosts that ravage the fields south of 37th parallel. Years of systematized energy are frustrated in a few days—perhaps hours—by a single cruelty of nature, such as a plague of locusts, a tropical rain, or a devastating hail storm. It will take years to bring the surplus lands of Argentina into cultivation, and the population is even now insufficient to supply labor at seed time and harvest.

During the next twelve years, Uruguay may add a million acres to the world's wheat fields, but social, political and economic conditions seriously interfere with agricultural development.

At the present time South Africa is an importer of wheat, and the regions suitable to cereals do not exceed a few million acres. Great expectations have been formed as to the fertility of Mashonaland, the Shire Islands, and the Kikuyu plateau, and as to the adaptation of these regions to the growth of wheat. But wheat culture fails where the banana ripens, and the banana flourishes throughout Central Africa, except in limited areas of great elevation. In many parts of Africa insect pests render it impossible to store grain, and without grain stores there can be little hope of large exports.

North Africa, formerly the granary of Rome, now exports less than 5,000,000 bushels of wheat annually, and these exports are on the decline, owing to increased home demands. With scientific irrigation, Egypt could supply three times her present amount of wheat, although no increase is likely unless the cotton fields of the Delta are diverted to grain growing. In Algeria and Tunis nearly all reclaimed lands are devoted to the production of wine, for which a brisk demand exists. Were this land devoted to the growth of wheat, an additional five million bushels might be obtained.

The enormous acreage devoted to wheat in India has been declining for some years, and in 1895 over 20,000,000 acres yielded 185,000,000 bushels. Seven-eighths of this harvest is required for native consumption, and only one-eighth on an average is available for export. The annual increase of population is more than 3,000,000, demanding an addition to the food-bearing lands of not less than 1,800,000 acres annually. In recent years the increase has been less than one-fourth of this amount.

In surveying the limitations and vicissitudes of wheat crops I have endeavored to keep free from exaggeration, and have avoided insistence on doubtful points. I have done my best to get trustworthy facts and figures, but from the nature of the case it is impossible to attain complete accuracy. Great caution is required in sifting the numerous varying current statements respecting the estimated areas and total produce of wheat throughout the world. The more closely official estimates are examined, the more defective are they found, and comparatively few figures are sufficiently well established to bear the deductions often drawn. In doubtful cases I have applied to the highest authorities in each country, and in the case of conflicting accounts have taken data the least favorable to sensational or panic-engendering statements. In a few instances of accurate statistics their value is impaired by age; but for 95 per cent. of my figures I quote good authorities, while for the remaining 5 per cent. I rely on the best commercial estimates derived from the appearance of the growing crops, the acreage under cultivation, and the yield last year. The maximum probable error would make no appreciable difference in my argument.

The facts and figures I have set before you are easily interpreted. Since 1871 unit consumption of wheat, including seed, has slowly increased in the United Kingdom to the present amount of 6 bushels per head per annum; while the rate of consumption for seed and food by the whole world of bread eaters was 4·15 bushels per unit per annum for the eight years ending 1878, and at the present time is 4·5 bushels. Under present conditions of low acre yield, wheat cannot long retain its dominant position among the food-stuffs of the civilized world. The details of the impending catastrophe no one can predict, but its general direction is obvious enough. Should all the wheat growing countries add to their area to the utmost capacity, on the most careful calculation the yield would give us only an addition of some 100,000,000 acres, supplying, at the average world yield of 12·7 bushels to the acre, 1,270,000,000 bushels, just enough to supply the increase of population among bread eaters till the year 1931.

At the present time there exists a deficit in the wheat area of 31,000 square miles—a deficit masked by the fact that the ten world crops of wheat harvested in the ten years ending 1896 were more than 5 per cent. above the average of the previous twenty-six years.

When provision shall have been made, if possible, to feed 230,000,000 units likely to be added to the bread eating population by 1931—by the complete occupancy of the arable areas of the temperate zone now partially occupied—where can be grown the additional 330,000,000 bushels of wheat required ten years later by a hungry world? What is to happen if the present rate of population be maintained, and if arable areas of sufficient extent cannot be adapted and made contributory to the subsistence of so great a host?

Are we to go hungry and to know the trial of scarcity? That is the poignant question. Thirty years is but a day in the life of a nation. Those present who may attend the meeting of the British Association thirty years hence will judge how far my forecasts are justified.

If bread fails—not only us, but all the bread eaters of the world—what are we to do? We are born wheat eaters. Other races, vastly superior to us in numbers, but differing widely in material and intellectual progress, are eaters of Indian corn, rice, millet, and other grains; but none of these grains has the food value, the concentrated health-sustaining power of wheat, and it is on this account that the accumulated experience of civilized mankind has set wheat apart as the fit and proper food for the development of the muscle and brain.

It is said that when other wheat exporting countries realize that the States can no longer keep pace with the demand, these countries will extend their area of cultivation, and struggle to keep up the supply pari passu with the falling off in other quarters. But will this comfortable and cherished doctrine bear the test of examination?

(To be continued.)

The Engineer gives particulars of two forms of artificial India rubber—one emanating from France, the other from Germany. Textiloid is the name of the French form. It consists of resinoline and admixtures. The resinoline is said to be obtained by treating oil with three or four times its bulk of metallic carbonates, and then with nitric acid. Then follow saponification, precipitation by means of an acid, and dissolution in alcohol or ether. A hundred parts of resinoline are mixed with twenty of zinc, oxide of manganese, etc., and sixty parts of methylated spirit. After several hours the mass is kneaded for one hour or more, and finally compressed. The German process consists in the oxidation of linseed oil, with the addition of prepared jute refuse, or similar hitherto worthless textile refuse, by which means a substance is produced which possesses many of the qualifications of genuine India rubber. It is capable of being utilized in many ways, and of being manufactured into various articles hitherto made of India rubber.

DEATH BY ELECTRICITY.

By W. S. HEDLEY, M.D.

IT is not always so easy as might be supposed to kill an animal by electricity. The experiments of Brown-Séquard and D'Arsonval long ago* showed this, and many physiologists have since confirmed it. Kratter found that one short application of an alternating current at 1,500 volts sometimes did not kill either rabbits or guinea pigs. Yet much lower voltages have often proved fatal to man. Indeed, it seems not improbable, as the present writer has elsewhere† stated, that all commercial forms of electric lighting currents, varying as they do from 80 volts upward, may be dangerous to human life under certain conditions. It is, of course, true to say that, other things being equal, risk increases in direct proportion to the electromotive force; but absolute equality of "other conditions" can never be secured.

The duration of the application, the nature of the contact, its superficial area and position, the condition of the skin, the periodicity of the current, the species of animal, its weight, age, and perhaps even its state of health, are all factors in the result. That duration of contact has a most important bearing on the question is nothing more than might be expected, for reasons both physical and physiological, and all experiment proves it. It has been shown‡ that currents, easily borne by an animal when momentarily applied, were fatal when the application was prolonged to 5 to 10 seconds.

On the other hand, short but repeated applications of strong currents were almost invariably fatal. When other conditions are the same, the larger the area of contact, the greater the intensity of the current; but the less its density, and the latter can never be left out of consideration in dealing with physiological effects. The condition of the skin, with reference to moisture, or any breach in its continuity, is also a point of the first importance, inasmuch as the epidermis is the great insulator of the body. But at the same time it is to be remembered that the degree of skin injury is not always proportional to the gravity of the accident. Frequency of alternation must also be considered. It may be that fatal effects are in inverse ratio to the periodicity, although not perhaps according to a strictly "straight line law."

Animals present differences in their resistances to the effects of electric currents according to their species, and even according to their individual peculiarities. Every animal seems in this respect to be a law only unto itself. It was found in the experiments already alluded to that rabbits often survived currents which proved fatal to dogs ten times bigger. In the original electrocution experiments in America, experiments were made upon a horse, three calves, and a number of dogs. The mean fatal current thus obtained was brought to bear upon the man to be executed, and the result proved a painful fiasco. Yet many experiences since then, some of them within recent months, have proved that a low as well as a high electromotive force may kill a man.

It is very generally admitted that in the case of animals killed by strong currents there is a tolerable uniformity in the post-mortem appearances: (1) the latter in many respects resemble those seen after death by asphyxia (apnœa); that is to say, the left side of the heart is comparatively empty, while its right side and the larger veins near it are distended and filled with dark fluid blood. The absence of hemoglobin from the blood is also a fact common to death by electricity and to death by apnœa. (2) The nervous system does not seem to present any very characteristic appearances, at least there is no "gross lesion" which can be said to be constantly present; but slight hemorrhages in the walls of the fourth ventricle and in the meningeal coverings are not rare. Yet there may be many finer molecular changes in the nervous tissues of which present methods of investigation are not able to make us cognizant. (3) The points of penetration of the current are always evidenced by burns of various degrees. Less constantly the place of exit is similarly marked. These burns of entrance have considerable diagnostic value in cases when the cause of death may be in doubt. They may vary in severity from simple redness to complete destruction of the whole thickness of the skin; but, as already said, their severity has no close relationship with the gravity of the accident.

When a strong current is brought to bear upon a living animal, there is immediately a strong tetanic contraction of the entire striated muscular system; and on the circuit being broken there is often a deep inspiration, perhaps followed by an "expiratory cry." It is often this cry which first calls attention to the accident. In cases which are not fatal there is often loss of consciousness, which may be regarded as the clinical manifestation of the severe shock, or rather shaking, to which the whole central nervous system has been subjected. This is very different from what is surgically known as "shock." In the latter, the longer the condition of shock lasts, the greater the danger. In electric accidents, danger of death diminishes the longer the duration of loss of consciousness. It may be said that, if not immediately killed, the person usually recovers. This loss of consciousness soon disappears, perhaps, even in a few minutes, but for days or weeks there may remain "head symptoms," such as vertigo and severe headache, or there may be palpitations or other such consequences. Neither sensory nor motor paralysis appears to be common.

Death, as the result of electricity, must occur in one of two ways: (1) by mechanical lesions of vital structures, or (2) by arrest of organic functions essential to life; that is to say, by arrest of respiration, heart action, or nutritive exchanges. It is in persons killed by lightning that the first named mechanical or "disruptive" effects are usually seen. Industrial currents kill in the second way. But even here the difference is quantitative rather than qualitative. Most of the foregoing points have been put in evidence by Kratter and others, and, as already said, are generally accepted.

* 1884.

† Electrical Review, January 28, 1898.

‡ Kratter.

The first class of cases need not be considered. It is self-evident that mechanical disintegration of vital parts must cause death. But, approaching the second class of cases, where death occurs by arrest of organic functions essential to life, the question broadens out, and it becomes necessary to inquire which of such functions is struck first. Where does death begin? What is the "mechanism" of death by electricity? At this point physiologists are no longer in accord.

Is it, as D'Arsonval considers, that, acting on nervous centers, the electric current produces a variety of effects known as "inhibitory," viz., suspension of respiration, arrest of heart action, etc., and that it is the first of these that is primarily affected, inasmuch as cardiac action persists after the arrest of respiration? According to this view, there occurs, in fact, "a central paralysis of respiration, constituting a special form of asphyxia,"* due to exhaustion of the medulla and functional death of the ganglion cells. If this be correct, artificial respiration affords a hopeful means of restoring animation. This condition of suspended respiration must not be mistaken for death, and a post-mortem examination at once proceeded with. "Nécropsiés vivants" is the sensational term which, it may be remembered, was used in connection with the autopsy of the first electrocuted criminals in America.

Dr. Tatum, of New York, experimenting in 1890, came to the conclusion that strong currents kill by acting chiefly or entirely on the actual substance of the heart itself.

In 1895, Dr. L. Jones, having witnessed some experiments undertaken by Mr. Bokenham with reference to the amount of current required to kill anæsthetized cats, considered, from an inspection of the respiration and blood pressure tracings, that death began at the heart, and that the action of the current is "upon the heart muscle rather than upon any of its nervous mechanisms." In The British Medical Journal of January 15, 1898, there appears a paper by Drs. Oliver and Bolam on the same subject, arriving at the same conclusion and by the same methods, but not giving such details of amperage and voltage as would enable the experiments to be repeated by others.

Against these latter views it has been urged that, were the heart's action suddenly arrested by the electric shock, there would not be the great disproportion in the amount of blood on the two sides of the heart that is present in death by electric shock. After sudden arrest of the heart's action, the amount of blood on the two sides of the heart is nearly equal. Further, the heart theory rests chiefly on blood pressure tracings, and it is to be remembered that blood pressure is the result of other factors, in addition to the action of the heart.

This leads to another hypothesis. Dr. Bleile, of the Ohio State University, suggests, as the result of carefully conducted physiological experiments, that death by electric shock is entirely due to the fact that the current produces a contraction of the arteries through an influence on the nervous system; that is to say, through an effect on those nervous centers which control the diameter of the arteries, and that a constriction of the arteries so produced throws in such an impediment to the flow of blood as the heart is unable to overcome. This last named hypothesis no doubt contains an important truth, recognizing, as it does, the fact of peripheral obstruction as influencing blood pressure.

It is, however, contended† that the fatal obstruction is not in the systemic arterioles, but is owing to a constriction of the pulmonary arterioles, the latter being excited to contract by the entirely deoxygenized blood. Such a theory obviously falls into line with the post-mortem conditions, which, as has been seen, resemble those seen in apnœa.

It would, therefore, appear, not, perhaps, that each of these hypotheses are at hopeless variance, but that death from electricity may be accomplished by various physiological mechanisms. First, and perhaps oftenest, it may be by sudden arrest of respiration; at another time it may be brought about by sudden and primary stoppage of heart action; in either case the result being not improbably due to physiological death of the centers of respiration or circulation from chemical and morphological changes therein, which present methods of observation do not enable us to recognize. Further, it is certain that these two centers act in unison, and it need not be surprising that the incidence of the damage done by the current may not always be distributed in the same way. But in accepting the foregoing it is not to be overlooked that the view that fatal results from electric currents are due to damage inflicted within the actual structure of the heart itself is very influentially held, it has never been disproved, and may ultimately turn out to be a cause, if not the cause, of death from electricity. Thirdly, mechanical or disruptive lesions, such as tearing of blood vessels and contusions of the surface of the brain, are not limited exclusively to accidents by lightning, but have also been observed in a modified form in cases of death from industrial currents.

A short code of rules for guidance in such accidents has been ably formulated by The Electrical Review, and the present writer has dealt with the subject of "first aid in electric accidents" in an article under that name in The Lancet, August, 1894. It is sufficient to say that, notwithstanding the experiments of physiologists and a growing experience of such cases, all that medical treatment can do is still to be summed up in the original formula of D'Arsonval, "Un foudroyé doit être traité comme un noyé;" in other words, by artificial respiration commenced early and continued long. But there is one further point with reference to this to which brief allusion may be made. It is known to physiologists that animals to whom nitrite of amyl has been administered are more difficult to kill by electric currents than are animals not under the influence of that drug. It acts by paralyzing the walls of the small blood vessels and so doing away with both arterial constriction and pulmonary obstruction. Now, without advocating that capsules of amyl nitrite should form part of the equipment of every "first aider," it may be suggested that the use of this drug in cases such as drowning and electric shock would in safe hands prove a valuable adjunct to artificial respiration.—The English Electrical Review.

* Kratter.

† Lancet, October, 1895.

A PECULIAR STYLE OF LADDER.

Fig. 1 represents a style of ladder that may be employed for different purposes. Its rounds, *A B*, are attached to each other at a proper distance apart by the ropes, *C*. The extremity of each is different in size and shape. The large end, *A*, is hollow, and the end, *B*, is pointed. In this way these different rounds can be fitted into one another and form, together, the long pole, *D*, at the upper end of which there is a large iron hook, *E*.

This pole, *D*, being of the length necessary to reach the place to which you wish to ascend, you can easily fix its hook, *E*. After this you have only to pull its lower end, that is to say, the first round, in order to draw out all the other rounds, when you will find that your pole, *D*, will change into a ladder.

These sorts of ladders are very convenient. They are so much the better adapted for secret expeditions in that they are very light, and, when taken apart, can be inclosed in a bag and carried without any one suspecting what the latter contains.

The ladders represented in Fig. 2 are excellent for surprising a city.

Each large ladder, like the one marked *A*, consists of several portions, or, more correctly, of several small ladders, which together form one sufficiently long to reach from the moat to the rampart. As may be seen from the figure, those portions of the ladder marked *B* are wider at their lower than at their upper end, in order that they may fit one into the other; and in order that they may be fitted together accurately, all the extremities of their branches are so shaped as to receive the last prolonged rounds of one and the first rounds of the other. These different junctions are provided with iron bands that sufficiently strengthen them and render the large ladder still more solid than if the branches were in a single piece.

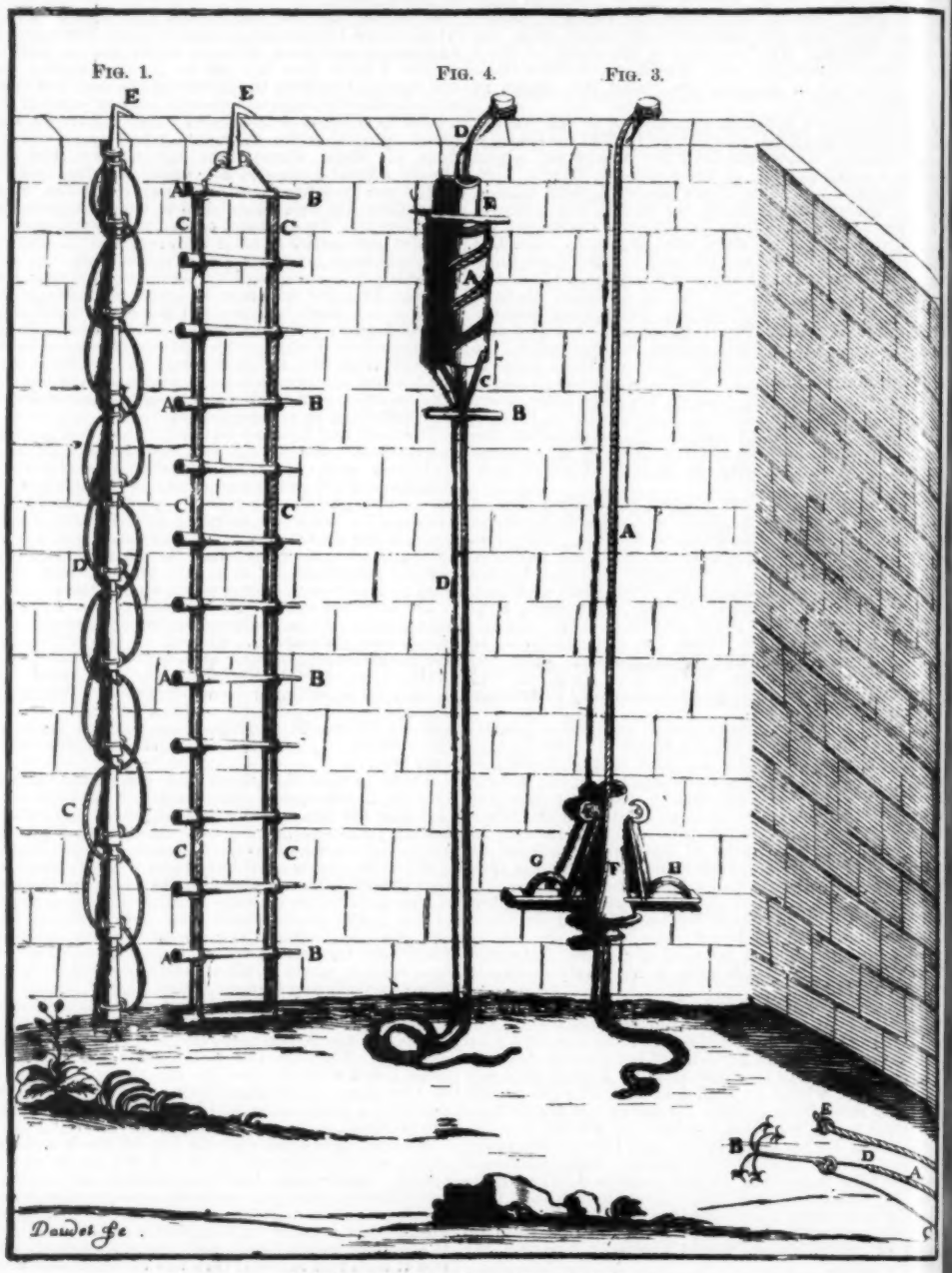
At the upper end of the large ladder there are rollers, *C*, that facilitate the placing of it against the wall; and there are added also to the lower end the spikes, *D*, so that after it is put in place and a person ascends it may not slip.

If it is a question of using this machine in order to surprise a hostile place, it will be necessary, before all else, to be informed as to the exact height of the escarpment, that is to say, as to the height of the wall of the rampart—a fact that can be readily ascertained. According to such height, you will have secretly constructed a certain number of the small ladders, *B*, in order to form the number of long ones, *A*, that you judge that you will need. After this you will distribute among the soldiers employed on the expedition these sections, which, being short, are light and easily carried. Thus each of the soldiers will readily carry his portion of the ladder along with his weapons, and when all have reached the foot of the wall they will immediately assemble the pieces, and, having put the ladders in place, will be in a condition, in less than a quarter of an hour, to scale the wall before the enemy can offer any opposition—especially if the enterprise can be managed very secretly, and if, in order to carry it out, the darkness of night be taken advantage of.

In Fig. 3 may be seen a method of ascending with much facility along a rope in order to enter a place of war during the night, or to get into a room situated at a height, through the window.

If you have some correspondence in the place which you desire to get into, one will be able to throw you the rope, *A*, that he has firmly fastened by its upper end. If you have no correspondence in the place, you will be able to throw the grapnel, *B*, which will hook itself firmly, especially if the parapet of a rampart be in question.

In throwing this grapnel upward you will have it accompanied with a string, which will not prevent it from



A PECULIAR STYLE OF LADDER.

rising and following the impulsion of the hand. The string should be very long and pass through the ring of the grapnel, so that when the latter is once well hooked, the string can cause the passage through it of the rope, *A*, which is attached to its ends. It may be easily understood, this is done in the following manner:

The string is pulled by its end, *C*, not only until the rope attached to its end, *D*, has ascended to the grapnel, but also until the rope has itself all passed through the ring of the grapnel. Then the larger knot at the end, *E*, of the rope prevents it from sliding further through the ring and firmly arrests it therein. The rope, *A*, being by one of these methods well fixed at the place at which you desire to ascend, you will put on the rope the piece, *F*, which is a sort of grip having stirrup irons, *G* and *H*, at the end of its branches, and which grasps or releases the rope, as need may be. Then after passing your feet into the irons, *G H*, you grasp the rope, *A*, with both hands at as high a point as possible, and, in raising yourself to such point, you draw the grip up with your feet. After this first maneuver, you make use of your feet, which are always in the stirrup irons, for closing the grip, and as the more you bear upon these irons the more tightly the grip closes and the more firmly it grasps the rope, you

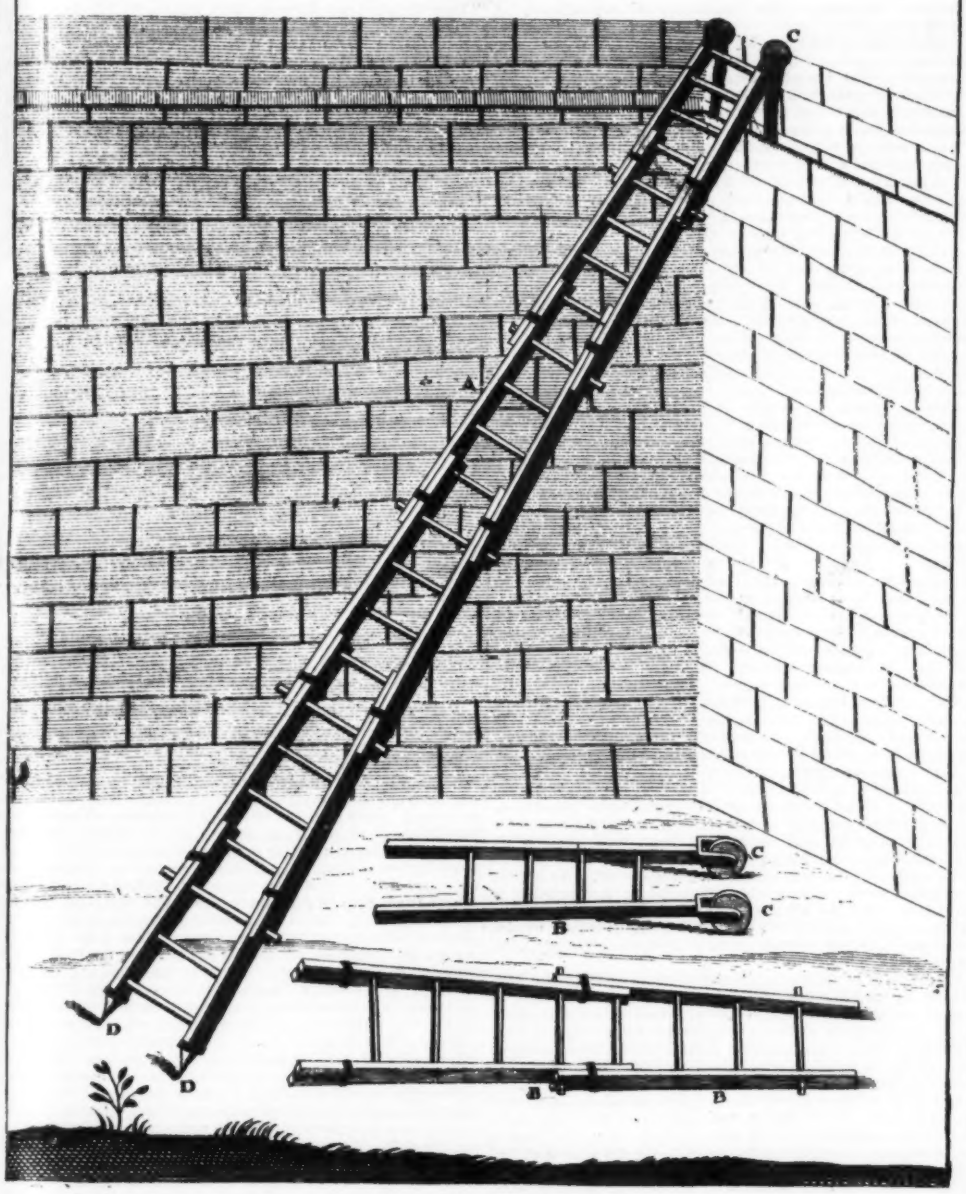
will allow youself to be carried thereon entirely. Releasing the rope and seizing it at a point a little higher up, you repeat the same maneuver.

Finally, in continuing these two motions, as I have just explained, that of the hands and that of the feet, you will insensibly ascend along the rope without much trouble, and even without any other danger than that which might happen to you were the rope not fastened firmly enough at the place where you desire to ascend.

Fig. 4 shows a very simple and very convenient method of sliding along a rope and descending from a place, even a very high one, without trouble and without any injury to the hands. Having taken the piece of wood, *A*, which is spirally grooved upon its surface, and to which, with the rope, *C*, you have attached the stick, *B*, through the middle of its length, you pass the rope, *D*, through the grooves of the said piece, *A*. After this, having placed yourself astride the stick, B, you grasp the rope, *D*, along which you are to descend. Thus, as you are suspended from the piece, *A*, and as the latter cannot slide along the rope because of the friction that it causes thereon, you will, in measure and in proportion as you release the rope, be able not only to descend gently, if you so desire, but also to stop wherever you wish.

To the upper end of the piece, *A*, there may be added another piece of wood, *E*, having an aperture in the center and covered with leather to protect the fingers. You can rest your left hand upon this piece, *E*, while with the right you release or grasp the rope, *D*, at your fancy; but this added piece appears to me to be quite useless.—From Recueil d'Ouvrages Curieux de Mathematique et de Mecanique, 1733.

FIG 2.



A PECULIAR STYLE OF LADDER.

THE TELEPHONE IN ITALY.

THE telephone concession of Florence, says The London Electrician, includes the town and the adjoining suburban communes, with a population of about 250,000 inhabitants. The telephone was introduced into Florence by two companies—one Italian and one English—both holding concessions for Bologna as well as Florence, the Italian concession including Leghorn. In 1883 the two companies amalgamated and formed the Societa Telefonica per l'Italia Centrale, with a capital of $300,000. The early concessions granted by the government had only the duration of three years, after which the government was at liberty either to renew the concessions, grant new ones, or to establish governmental telephonic communication. To this latter effect the government presented a bill to Parliament by which all the existing concessions at their expiration were canceled without any right of compensation or any obligation on the part of the government to buy the lines and offices already established. This bill, approved by the lower House, was rejected by the Senate. A new bill was then presented and approved by Parliament by which the right of granting concessions for private or public telephonic communication was entirely reserved to the government. The law fixed the duration of each concession to twenty-five years, after which all the plant, line, and premises became the property of the state. The government has also the right after twelve years from the date of each concession to take possession of the concern by paying a sum equal to the average net profit of the three preceding years multiplied by the number of years which each concession has still to run to reach the final period of twenty-five years determined by law.

The same law establishes a tax of 10 per cent. on the gross profits of each concession for public use, the right of free communication for all the postal and telegraphic offices, and a reduction of 50 per cent. on the public tariff in favor of all government, provincial, and municipal offices. As a compensation, however, the companies have the right to fix wire supports on all public and private properties. When a private proprietor refuses to grant the permission, a simple application to the prefect is required to obtain the enforcement of the law. The proprietor may ask for an indemnity, and if both parties do not agree, the prefect decides if any and what amount for once only is to be paid. As soon as the Italian telephone companies saw their existence insured for a fixed period, they began to reorganize their services by changing the apparatus, wires, etc., with the object of diminishing working expenses, so as to enable them, besides distributing a dividend to the shareholders, to yearly set apart a sum for the reimbursement of the capital at the expiration of the concession. Experience proved that these objects could not be attained by small companies, on account of the heavy expenses of management and the necessity of having a uniform technical direction, and they therefore amalgamated and formed larger companies. This amalgamation is now under execution.

Florence is now a branch exchange of the Societa Generale Italiana dei Telefoni ed Applicazioni Elettriche, with a capital of $1,200,000, and owns the telephonic exchanges of Rome, Naples, Genoa, Palermo, Venice, Leghorn, and most other important towns, with the exception of Milan and Turin, where the old local companies have formed the Societa Telefonica per l'Aita Italia. The number of subscribers in Florence is only 900, and the following is the tariff of rates charged: $32 within 1,093·61 yards from the central office, $36 within double that distance, $40 within three times above distance, and for further distances $1.40 for every 218·722 yards. The apparatus and instruments were wholly supplied by the Antwerp Telephone and Electrical Works. The wire used is silicon bronze for the lines in the interior of the town and steel or iron for the country. All subscribers have the right to complete service day, night, and Sundays.

The operators are females, hours from seven to eight per day, salary from $6.25 to $12.50 per month. A fortnight's leave of absence is granted yearly and a holiday on each alternate Sunday. Workmen employed in the maintenance of apparatus receive from 40 cents to 62 cents per day; linemen from 40 cents to 50 cents, with a holiday on every alternate Sunday and a half holiday on Saturdays. All workmen are insured against injury or death, this insurance being obligatory by law. In case of injury, full wages are paid during illness; in case of permanent disablement 900 days' wages, and the same compensation is due to the families in case of accidental death. In ordinary sickness workmen are supported by the company for a certain period according to length of service, but in no case under three months. Hours of work ten, with 4 cents for every extra hour. During the summer months a few days' holiday is granted. Each workman has from 150 to 200 instruments to look after.

The original local company distributed a dividend varying from 2 to 3 per cent. The new amalgamation has not yet published a balance-sheet, but it is expected that the dividend, if any, will not be in excess of the above rate. With a 10 per cent. concession tax and 20 per cent. income tax, and the necessity of refunding the capital, very little extra profit is likely to be available for distribution.

COLOR VISION.*

THE domain of physiological optics, formerly much frequented by students of physics, has of late been administered chiefly by psychologists. So far is this true that I have hesitated, in preparing an address upon a subject in this realm, lest I should be accused of passing entirely beyond that borderland which lies between us and our sister science, of trespassing in a foreign country, and risking international complications. Yet a subject which has owed its development to Newton and Young, Maxwell and Helmholtz, to mention no other names, can hardly be out of place here. The methods of investigation are largely those of the physicist, the phenomena attend every optical research, the results are of frequent physical application. Within the past few years, however, most of the work on color vision has been done by other hands, and the results have not appeared in the physical journals. It seemed worth while, therefore, to review briefly the progress of scientific theory in this direction, and to sum up, so far as possible, the present state of our knowledge.

For our purpose we must go back as far as Sir Isaac Newton, to whom we owe the first definite and intelligible hypothesis as to the nature of color vision.

"If at any time," he says, "I speak of light and rays as colored or endued with colors, I would be understood to speak, not philosophically and properly, but grossly, and according to such conceptions as vulgar people in seeing all these experiments would be apt to frame. For the rays, to speak properly, are not colored. In them is nothing else than a certain power and disposition to stir up a sensation of this or that color.

"For as sound in a bell or musical string or other sounding body is nothing but a trembling motion, and in the air nothing but that motion propagated from the object, and in the sensorium 'tis a sense of that motion under the form of sound; so colors in the object are nothing but a disposition to reflect this or that sort of rays more copiously than the rest; in the rays they are nothing but their dispositions to propagate this or that motion into the sensorium, and in the sensorium they are sensations of those motions under the forms of colors."†

Again, with greater definiteness, Newton writes:

"To explain colors, I suppose that as bodies of various sizes, densities, or sensations, do by percussion or other action excite sounds of various tones, and, consequently, vibrations in the air of different bigness, so the rays of light, by impinging on the stiff refracting superficies, excite vibrations in the ether . . . of various bigness; the biggest, strongest, or most potent rays, the largest vibrations; and others shorter, according to their bigness, strength, or power; and therefore the ends of the capillamenta of the optic nerve, which pave or face the retina, being such refracting superficies, when the rays impinge upon them, they must there excite these vibrations, which vibrations (like those of sound in a trunk or trumpet) will run along the aqueous pores or crystalline pith of the capillamenta, through the optic nerve into the sensorium; and there, I suppose, affect the sense with various colors, according to their bigness and mixture; the biggest with the strongest colors, reds and yellows, the least with the weakest, blues and violets; the middle with green; and a confusion of all with white, much after the manner that in the sense of hearing, nature makes use of aeriai vibrations of several bignesses, to generate sounds of divers tones; for the analogy of nature is to be observed."‡

These passages are quoted—and several others might be added—to show that Newton ascribes no peculiar function or activity to the terminals of the optic nerve. They are set in vibration by the rays of light; their vibrations are transmitted to the higher regions of the sensorium, where they become sensations of light and color. As to the physical nature of the rays themselves, or the reason why they should excite in the nerve

* Address by Frank P. Whitman, Vice-President and Chairman of Section B, and delivered before the American Association for the Advancement of Science.

† Opticks: 3d edition, 1721. p. 108.

‡ Quoted by Young, Phil. Trans., 1802, p. 19.

fibers vibrations of different length, Newton makes no guess.

This is a definite theory of color perception, and, as Rutherford has pointed out, one of great value, but presenting obvious difficulties.

Some of these difficulties led Thomas Young to that modified form of Newton's views which, in the famous Bakerian lecture, he describes as follows:

"Since . . . . it is probable that the motion of the retina is rather of a vibratory than an undulatory nature, the frequency of the vibrations must be dependent on the constitution of this substance. Now, as it is almost impossible to conceive each sensitive point of the retina to contain an infinite number of particles, each capable of vibrating in perfect unison with every possible undulation, it becomes necessary to suppose the number limited, for instance to the three principal colors, red, yellow and blue, . . . and that each of the particles is capable of being put in motion less or more forcibly, by undulations differing less or more from a perfect unison; . . . and each sensitive filament of the nerve may consist of three portions, one for each principal color." Young, as is well known, afterward substituted green for yellow in his triad of principal colors.

It is to be observed that the "particles" spoken of in the above quotation, as vibrating in unison with the undulations of light, are not to be considered as molecules, in the modern sense. He speaks of them as particles, then as sensitive filaments, and in a later paper on the same subject, as "sympathetic fibers." A supposition, such as has been urged, that Young is here speaking of molecular constitution, and anticipating the photochemical theories of our own day, is an anachronism. Young is thinking of the wave-theory of light, and of sympathetic vibrations, or, as we should say, of resonance. One who meant chemical decomposition would not speak of the shattered molecules as sympathetic fibers. Young, in fact, is not consciously proposing a new theory, much less one so startlingly different. He is simplifying Newton's, making for that purpose four hypotheses, three of which, as he remarks himself, "are literally parts of the more complicated Newtonian system." Young's theory seems to have attracted little attention, until brought once more to public notice by Helmholtz, in 1860.

Helmholtz suggests one objection to the theory, and a modification to obviate the objection, but remarks that the essence of the theory does not lie in this or that special assumption, but in the fact that the color sensations are conceived as compounded out of three entirely independent properties in the nerve substance.

Therefore, he says, if only for the sake of clearness of representation, he uses Young's original and simple form of statement, ascribing the different color sensations to three kinds of nerve endings in the retina, sensitive respectively to red, green, and violet light, the sensation of white to the equal excitation of all three sets of nerve fibers, and color blindness to the absence of one or more of the sets of such fibers. He puts into Young's words, however, an entirely different meaning, by classifying Young's hypothesis as "only a special application of the law of specific sense-activities." This statement, a most natural one to a pupil of Johann Mueller, changes the whole character of the theory, and makes it really a new one.

The hypothesis in this simple form met very well the conditions of normal vision, and the cases of color blindness thus far studied. Difficulties soon arose. Color-blind, especially red-blind, persons persisted in calling the principal colors seen in the spectrum, yellow and blue, instead of green and blue, as they should have done if the red sensation were simply absent. It was long supposed that this was merely a question of naming the colors, and that those actually seen were green and blue. So lately as 1892 the report of the British Association committee on color vision contains colored spectrum plates, in which the spectrum as seen by a red-blind person is shown as composed of green and blue, while that seen by a green-blind person is formed by red and blue. Abney prefixes the same plate to his Tyndall lectures on color vision, published in 1894. But in 1881, Hippel* and Holmgren† had examined the vision of a person, one of whose eyes was normal, the other typically color-blind. All the long-waved end of the spectrum was described as yellow, the sensation being tested by comparison with the normal eye. Other cases of color-blindness, arising from disease, corroborate this testimony. It is evident that a simple absence of one of the fundamental sensations is not enough to account for the facts.

But more than the ordinary color blindness comes into the question. It was discovered that the normal eye is color blind by indirect vision, the condition gradually increasing from the central portion outward, and culminating in the periphery of the retina in absolute insensibility to color. The sensation of white cannot in this case be produced by a mixture of three color sensations, because color sensation does not exist.

In 1777 was described, in the Philosophical Transactions of the Royal Society, the well known case of the shoemaker Harris, apparently the first recorded case of complete color blindness. In 1871 Donders made a careful study of another case. So rare is this defect, however, that so assiduous an observer as Holmgren in 1877 had never seen it and doubted its existence, and in 1889 Helmholtz simply passes it by, saying that the eye so affected is always in other ways ailing and sickly, the implication being that the effect was so far from the ordinary and so pathological in character that it need not be considered. But by 1892 a sufficient number of such cases had been examined to establish the existence of this as a distinct type of color vision, and one which must be accounted for.

A third and even more striking departure from the simple conditions of the original theory was found in the remarkable change in the character of color sensations in faint light, the spectrum becoming simply a colorless strip of graduated brightness.

We have then three different types of varying color sensibility:

1. In the eyes of different persons, beginning with the normal eyed, passing through the variation studied by Rayleigh and Donders, which, while recognizing all colors, yet in the character of the sensations makes a step toward green blindness, then the two well marked divisions of the color blind, red and green blind, and finally the eye which perceives no color. These different classes are well marked, and few intermediate forms are found.

2. In the same eye, under differing degrees of brightness. As the spectrum gradually diminishes in brightness, the colors change. Red tends toward yellow, yellow toward green, green becomes bluish. All the colors vanish by degrees, red disappearing first, and the spectrum, still visible through the greater part of its length, appears without color. Here the intermediate stage is a sort of red blindness, but the final result is the same for all eyes, that is, the distribution of brightness for the normal and the color blind eye appears to be precisely the same, a circumstance, as we shall see, of much importance.

3. In a single eye, passing from the center outward. The fovea and the zone surrounding it are sensitive to all colors. Outside of this the eye becomes gradually insensitive to color, the sensation of red and green disappearing first, afterward yellow, and finally blue. The outer part of the retina is insensitive to all color, but its condition may be quite different from that of the eye of a totally color blind person, or a normal eye in faint light.*

In attempting to account for these varied phenomena, the Helmholtz theory loses its striking simplicity. It is no longer possible to explain color blindness by the absence of one or more sets of sensitive fibers, or the white seen by a totally color blind retina, as compounded from the three fundamental sensations, in any ordinary way.

Helmholtz, in 1860, made the suggestion, which was afterward amplified by Fick and König, of a possible changeability in the character of the three fundamental sensations. Albert, in 1882, from a study of the color changes in faint light, pointed out the direction and character of the corresponding sensation changes.†

A method by which such changes might be brought about was not difficult to suggest. The idea of Newton and Young, of nerve fibers vibrating in unison with the light waves, had grown increasingly improbable as on the one hand the rate of vibration of light became known, and on the other the maximum rapidity of vibration transmissible by a nerve fiber, which is a quantity of an entirely different order. Hence most modern theorists have turned to photochemical action, and Helmholtz among the rest, although, with characteristic caution, he advocates no particular form of light effect, resting the claims of his theory, in the second edition of his great book as in the first, on the physical possibilities of representing all colors by means of three. But if we suppose red sensitive, green sensitive, and violet sensitive molecules, there is no difficulty, when one thinks of modern photographic processes, in supposing that the green sensitive substance, for example, may be so chemically changed as to coincide in character with the red sensitive. Each would send to the brain the impression of its own characteristic color, while each would be affected in exactly the same manner by any given light. In other words, the color curve, corresponding to the sensation of the fundamental green in the Young-Helmholtz theory, would be more or less perfectly superposed upon that of the fundamental red.

As a result, there would be no more sensation of green or red, but only of their compound—yellow. Now this is just what a color blind person sees, as Hippel and Holmgren showed in their long neglected papers already referred to.

So peripheral color blindness may be explained by a gradual approximation of the three color substances and a gradual superposition of the corresponding sensation curves, until in the outer zone all three coincide.

But when we attempt to apply this suggestion to all the changes noted before, in ordinary color blindness, peripheral color blindness and twilight color blindness, as Von Kries happily calls it, the shifting of the curves becomes so great and so various that we realize that we are dealing no longer with a scientific theory, but with a fanciful and arbitrary arrangement. As a first approximation, the Young-Helmholtz hypothesis is valuable, leading to simple and definite connections between great numbers of facts. As a detailed explanation of existing phenomena, it is unsatisfactory, and growing more so daily.

One thing is becoming steadily evident, that the sensation of brightness, perhaps also the sensation of white, must be accounted for in some other way than as a summation effect of separate color sensations. Another class of phenomena points yet more directly to this view. I refer to the discovery of Rood that the effect of sudden variations in brightness, the "flicker" sensation, is dependent on brightness alone, and not upon color. It is difficult for one who has seen how easily and definitely a red and a gray or a red and a blue can be compared in brightness by this method to believe that brightness is not an independent sensation. The words of Helmholtz are worth quoting here. "As to myself," he says, "I have always the feeling that in photometric comparison of different colors it is a question, not of the comparison of one sort of magnitude, but of the combined effects of two, brightness and color, of which I cannot form a simple summation and of which I can give no scientific definition."

The strongest point of attack upon the Young-Helmholtz color theory has, in fact, always been the explanation of the white sensation, and one of the principal advantages of the theory proposed by Hering in 1874 was the separation of the white sensation, which he identified with the sensation of brightness, from special connection with the color sensations, or rather his including it, upon the same level, in the list of his three sets of opposing colors, black-white, red-green, yellow-blue.

A photo-chemical substance is supposed to exist in the eye—where, it is not decided—which possesses the remarkable property that, if acted upon by light of one wave length, its molecules are dissociated or dissimilated; if acted upon by light of another wave length, they are built up or assimilated again. This substance exists in three forms; one is, let us say, dissimilated by red light, assimilated by green; one is similarly acted upon by yellow and blue, and one by white and black. There are thus six color processes, arranged in three pairs. They are antagonistic in character, so that if red and green, or yellow and blue light act on the retina at the same time and with equal strength, they neutralize each other and the sensation of color is completely destroyed. It is difficult to form a clear conception of these processes. Photo-chemical actions of a somewhat antagonistic character are well known, but the analogies between them and the visual processes are hardly close enough to be of great assistance.

The hypothesis, however difficult to conceive of in itself, is very definite, and explains as well as the Young-Helmholtz theory, the results of ordinary color vision, and in respect to subjective phenomena, as contrast, or after-images, is much more satisfactory, in formal statement, at least.

But it fails equally, though for different reasons, to explain satisfactorily the more lately discovered or less evident phenomena of vision.

Complementary colors are regarded, on this theory, as mutually destructive, the one representing an assimilative, the other a dissimilative process. The white or gray which results from their combination is due to the action on the white-black visual substance, which was unperceived in the separate colors, being masked by their greater brilliancy, but becomes effective when they are neutralized by mixture. If two equal grays are formed, one let us say from red and green, the other from yellow and blue, they must according to the theory contain equal amounts of white, and the colors in each are completely neutralized. They should therefore remain equal at all degrees of brightness. But Ebbinghaus,* by mixing special colors, and Mrs. Franklin,† with color disks, have shown that this is not true. If they are made equal when bright, and the intensity gradually diminished, the red-green mixture greatly exceeds in brightness. If they are equated when of feeble intensity, and then made brighter, the yellow-blue mixture surpasses. König‡ has lately examined this with much elaboration, confirming these results, and showing also that the brightness of a gray obtained thus by mixture is always equal to the sum of the brightness of the separate colors, whether by bright or faint light.

This single experiment, so amply confirmed, appears completely destructive to Hering's fundamental hypothesis, at least in its original and simple form.

It may be remarked in passing that photometric methods which have been proposed, of comparing lights of different colors by reducing their brightness until the color differences vanish, are worthless.

Other phenomena of similar character exist which are equally difficult of explanation. Hering regards some of these as phenomena of adaptation, and shows, in his remarkable paper on Purkinje's phenomenon, published in 1895, that the state of the retina, as conditioned by previous exposure to light, affects greatly the perception of color. Attention to this fact is necessary in photometric comparisons. The eye should be kept in the same condition, as nearly as possible, throughout any set of observations. But careful measurements by Von Kries and others, keeping the eye carefully adapted for brightness, have proved that Purkinje's phenomenon exists, whatever the state of the eye, though much modified by adaptation.

(To be continued.)

* Arch. f. Ophthal., xxvi. (2), p. 173, 1880; xxvii. (3), p. 47, 1881.
† See Proc. Roy. Soc., No. 209.

* Von Kries, Centralblatt f. Physiologie, x., pp. 745-749, 1896.
† Albert, Wied. Ann., 18, p. 129, 1882.

[Continued from Supplement, No. 1187, page 19034.]

THE DEVELOPMENT OF PHOTOGRAPHY IN ASTRONOMY.§

From the importance of a more thorough understanding of the effects of the sun upon the climate of the earth, daily photographs of the solar surface are made at a number of observatories, principally at Greenwich, Kew, and in India. These have been kept up for a great many years. The Lick observatory has in recent years also taken up this subject. It is scarcely probable that a single day goes by without photographs of the sun being made at some one of these observatories. Thus a valuable record is kept of the changes taking place on the solar surface. Just what effect these sun storms have upon the earth is not yet definitely understood, but there seems to be an almost certain connection between some of the solar disturbances and terrestrial magnetic storms, so that when the sun is violently agitated a corresponding disturbance of the earth's magnetism occurs. It is not yet seen just how these disturbances may affect the weather; so far the testimony seems inconclusive, and local conditions on the earth may fully compensate for any effect solar storms might have here. In the meantime the work done in this connection at Greenwich and other places will continue to grow in importance. One thing that this repeated and constant photographing of the sun has proved is the non-existence of the so-called intra-Mercurial planets, which before the days of photography were so frequently seen transiting the sun, by Lescarbault and many others. No strange thing, aside from an alleged comet, which was afterward traced to a stain on the photographic film, has been shown on any of these photographs, with the exception, perhaps, of one of the sun photographs made in India which caught a distant bird in its flight and showed clearly its head and outspread wings projected against the sun.

Just as this continuous photographing of the sun's surface has forever disposed of the alleged frequent transits of intra-Mercurial planets, so will the photographic plate finally, when it has attained more perfection in dealing with the planets, show that many of the strange features ascribed to the surfaces of some of them do not exist.

As I have said, the early photographs of eclipses seem to have been made with the sole end in view of securing pictures of the solar prominences. This was very important at first, for by the photographs it was proved that they were true solar phenomena. Possibly, also, in the very first photographs a picture of the corona was considered a hopeless matter on account of the lack of sensitiveness of the plates. The eclipse of 1868 is memorable for having shown Janssen

* Zeitschrift fur Psychol. und Physiol. der Sinnesorgane, v., p. 145, 1893.
† Mind, N. S., II., p. 487, 1893.
‡ Ber. d. Preuss. Akad., p. 945, 1896.
§ Address of Prof. E. E. Barnard, Vice-President, before Section A—Mathematics and Astronomy—of the American Association for the Advancement of Science, August 22, 1898.

and Lockyer that the visibility of the prominences did not necessarily depend upon a total eclipse of the sun. They found that by the aid of the spectroscope the prominences could be seen and studied at any time. This was an extremely important step, and placed our knowledge of the nature of the prominences upon a firm and lasting footing. The fact that these objects could be made visible with the spectroscope soon suggested to Prof. Young the idea that they might also be photographed at any time; and in 1870 he made efforts to secure impressions of them upon the photographic plate, and met with partial success. To successfully photograph these objects, however, required the invention of a special instrument, for the older methods must necessarily result in failure. In observing the prominences visually with the spectroscope it is necessary to examine them through a slit which is very narrow compared with the height of the prominences. Only a small section of the prominence can, therefore, be seen at once, and to see it all the slit must be moved over the prominence. If the slit is widened, more of the object is shown, but at the same time such a flood of light is admitted that it is lost in the glare. If an instrument could be devised whereby the slit could be moved in front of a photographic plate, successively exposing to the plate all parts of the prominence, it will readily be seen that the entire image could be photographed. To do this there must be two slits moving in perfect unison—one placed across the sun in front of the grating or prism, the other in front of the photographic plate and adjusted perfectly to the spectral line of the prominence so as to exclude all light save that emitted by the prominence itself, and thus, by the gradual motion of these two slits, the entire object is successively uncovered and an exact photograph secured of it.

The solar prominences consist mainly of incandescent hydrogen and calcium. The best results are secured by calcium alone. It is curious to see photographs of the same prominence made by using the hydrogen or calcium lines independently; these pictures often differ considerably, thereby showing the peculiarity of distribution of the calcium and hydrogen in the same prominence. The two components are differentiated, and it is thus shown just what part each component takes in the composition of the prominence. To make one of these pictures takes several minutes of exposure, during which time the slits slowly travel over the region of the prominence. This extremely ingenious device owes its existence to the inventive genius of Prof. Hale, who devised and built the first instrument of this kind, and secured the first actual spectroscopic photograph of the prominences. The first pictures were made in 1891. It is, therefore, now a matter of no great labor to make not only photographs of single prominences at any time, but, through a further ingenious extension of the possibilities of the instrument, it is made to move across the entire sun's disk, thus securing every prominence at that time visible. By hiding the sun's image by an occulting disk in the first sweep, and then making a second similar but more rapid sweep with the sun's image uncovered, the sun itself, with all its faculæ, spots, etc., is impressed in the blank space left for it, and a complete picture of the sun and all its surroundings, with the exception of the corona, is secured. These pictures, however, show only those features of the sun which are due to hydrogen or calcium, and the solar surface thus appears very different from the telescopic view of it. The calcium regions come out with extraordinary distinctness, so much so, indeed, as at times to completely obliterate the sun spots, which at that moment are so distinct to the eye with the same telescope. Admirable work of this kind has also been done by M. Deslandres, of the Paris observatory, who has devised an instrument similar to that of Prof. Hale.

From the first photograph of a star by Bond in 1850 to the present time, stellar photography has gradually risen to a prominence as remarkable as it is important. The real increase of importance in this work, however, has occurred within the past ten or fifteen years, since the successful introduction of the very rapid dry plate. The wet or collodion process was poorly adapted to the photography of the stars, and of no use whatever for comets and nebulæ. As implied by the term "wet process," the plate must remain wet through the entire work from its first coating with collodion until its final washing as a negative. The exposure time must, therefore, be very limited. Not only was the exposure of limited duration (from fifteen to twenty minutes), but the plate was very slow in its action compared with the dry plate of to-day. The combination of these two difficulties made it impossible to photograph anything except the brighter stars. Dr. Gould, at Cordoba, managed to increase the exposure time by keeping a stream of water playing over the plate. This, however, might cause a deterioration of the film. With the inherent difficulties of the wet plate to contend with, it is little wonder that no faint stars, nebulæ, or comets were photographed. Notwithstanding this, the photographs of the star clusters, etc., of the southern skies obtained, under the direction of Gould with an 11-inch photographic refractor by the wet process, were of the highest value, and showed, upon measurement, a striking agreement in accuracy with visual work. The same can be said of Mr. Rutherfurd's photographs of the Pleiades, Præsepe, etc., which were made prior to Dr. Gould's, and which were the first photographs of this kind. These extremely valuable photographs of Rutherfurd are now receiving a most thorough measurement under the careful supervision of Prof. J. K. Rees, of Columbia College, where Mr. Rutherfurd's negatives are stored. To this institution Mr. Rutherfurd left his telescope and measuring instruments.

In 1857 Bond had shown, by measurement of a series of photographs of the double star Mizar, that the highest confidence could be placed in measures of star plates. This has been fully verified in late years by Gill, Elkin, and others. Dr. Elkin showed, in 1889, that measures of a photograph of the Pleiades taken by Mr. Burnham, with the great telescope at Mount Hamilton, had equal value with his heliometer measures of the same stars.

From the necessary conditions the collodion process could make no advance in stellar photography. Previous to 1876 experiments had been made to get a workable dry plate, and for the next six years more or less success had been attained in their manufacture. But the photographers themselves took hold of these plates with much caution because of their uncertainty. By 1881 or 1882, however, they were beginning to be used and gave considerable promise of their ultimate value, as was shown by the photographs of the comet of 1881, which were made by Draper and Janssen. These were the first photographs ever made of a comet. Efforts had been made to secure pictures of Donati's comet in 1858, but without success.

At the present time these plates are made so sensitive that a rifle bullet can be photographed in full flight; yet some of the celestial objects now photographed are so faint that it requires many hours' exposure with these same plates to show any trace of them.

In the fall of 1882 the world was thrilled by the advent of a magnificent comet which suddenly appeared near the sun in September, and for the next four or five months delighted astronomers with the splendor of its display. Attracted by the great brilliancy of the comet, Dr. Gill, at the Cape of Good Hope, with the aid of a local photographer and his photographic lens, secured a fine series of photographs of the comet with dry plates. When these photographs reached the northern hemisphere they attracted a great deal of attention, not only on account of the comet itself, but also from the number of stars that were impressed on the plates. At this period the Henry Brothers were making a chart of the stars along the ecliptic in their search for asteroids. They had at this time reached the region of the Milky Way, and the marvelous wealth of stars they encountered upon entering the boundaries of that vast zone completely discouraged them in their endeavors to carry their charts through the rich region traversed by the ecliptic. While hesitating as to the advisability of continuing their work, the photographs of the great comet came to their notice. They were struck with the great number of stars shown on these pictures along with the image of the comet. The idea at once occurred to them that they could use this wonderful process to make their charts. It was to this simple incident that the active application of stellar photography of to-day is due. They began at once the construction, with their own hands, of a suitable photographic telescope of 13¼ inches diameter for the photography of the stars. This instrument was soon finished, and the astronomical world knows to-day what wonderful results these men produced with it; the exquisite star pictures which were marvels of definition, the photographs of the nebulæ, of Saturn and Jupiter, the moon, etc., were perfect revelations.

In 1859, Tempel, at Florence, Italy, had found a diffused cometary-looking nebula connected with and extending southwesterly from the star Merope of the Pleiades. From that time on astronomers wrangled over this object, which many of them believed had no existence. One of the first things done by the Henry Brothers was to photograph the Pleiades. These pictures showed nebulous strips near Merope, and though they did not resemble any that had been drawn by the numerous observers of the Merope nebula, they rather confirmed the existence of Tempel's object. Upon these plates were shown a new nebula connected with the star Maia where none was previously known. It required the most powerful of existing telescopes to verify this visually. This was finally done, however, and it then began to dawn upon astronomers what great possibilities lay in the photographic plate for the detection and study of the nebulæ. It was soon seen that their light was strongly photographic; that it was really more actinic than visual. A later photograph with a longer exposure showed the Merope nebula just as the best observers had drawn it, and at the same time filled the entire group of stars with an entangling system of nebulous matter which seemed to bind together the different stars of the group with misty wreaths and streams of filmy light, nearly all of which is entirely beyond the keenest vision and the most powerful telescope. This was a revelation. The question had often been asked whether it would ever be possible to photograph as faint a celestial body as could be seen with a powerful telescope. Here was the answer. It was not only possible to photograph some of the faintest objects seen in the telescope, but it was possible also to photograph some others which could never be seen in the sky. In one of his reports, Admiral Mouchez called attention to the fact that the only way they could see the satellite of Neptune at the Paris observatory was on the photographs made by the Henry Brothers, for they had no telescope sufficiently powerful to show it visually.

The Henrys applied themselves assiduously to celestial photography, with the most remarkable success. They led the world in this work. While they were at the height of their activity, astronomers elsewhere were but beginning to awaken to the great importance of the subject. And yet there seems to have been essentially no public recognition of the work of these two men, to whom astronomy owes so much. In personal appearance and temperament they are so extremely dissimilar that one would scarcely take them to be brothers. Up to the time they began their photographic work they had between them discovered fourteen asteroids, by the slow and tedious visual process of picking them out by their motion from the countless thousands of small stars. If one examines a list of the asteroids, he will be struck with the manner in which these fourteen small planets are recorded. According to this list, the first one of these was discovered, in 1872, by Prosper Henry, the next one by Paul Henry, and so on, alternately, throughout the entire fourteen, until 1879, when the last one found was attributed to Paul Henry. It is a curious fact, and one which will be readily understood by all who are acquainted with the unselfish affection existing between these two brothers, that the credit for the discovery of these fourteen minor planets is ascribed alternately to Prosper and Paul Henry. It is likely we shall never know which brother discovered any one of these planets.

Singularly enough, the photographic plate not only did away with the necessity of making these charts by eye and hand to facilitate the discovery of asteroids, but it also did away with the necessity of the charts themselves for that purpose, for the little planet, which is moving among the stars, now registers its own discovery by leaving a short trail—its path during the exposure—on the photographic plate. The first of these photographic discoveries of asteroids was made by Dr. Max Wolf, in 1892. They are now found wholesale in this manner by photography.

It was the success of the Henry Brothers' work that led to the International Astro-Photographic Congress which met at Paris in 1886. It was their work that caused this Congress to meet at Paris. The Congress adopted the Henry Brothers' lens as a model for the instruments to be used, and the work of this great undertaking was based on that of the Henry Brothers. It was stated once by Admiral Mouchez that every object glass at the Paris observatory had either been made by the Henrys or refigured by them.

Perhaps, as Dr. Dick himself thought in the early days of photography, the most unpromising subject for the photographic plate to deal with was the nebulæ. Most of these objects appeared so feeble in their light that but little encouragement in that direction was offered the celestial photographer.

One of the brightest and most promising of nebulæ is that in the sword of Orion, and this was naturally one of the first of these objects to receive photographic attention. In September, 1880, Dr. Henry Draper began the photography of the nebulæ with this object, and succeeded, with 51 minutes' exposure, using the dry plate, in getting a good picture of the brighter portions of the nebula. This was the first nebular photograph. With 104 minutes' exposure in March, 1881, with an 11-inch refractor, he secured a still better plate, which showed stars down to the 14·7 magnitude, which were visually beyond the reach of the same telescope. But in March, 1882, he obtained the best picture of this wonderful nebula, with an exposure of 137 minutes. These pictures marked a new era in the study of the nebulæ. When these results were communicated to the French Academy by Dr. Draper, Janssen took up the subject with a silver-on-glass mirror of very short focus, having the extraordinary ratio of aperture to focus of ⅛; the aperture being 20 inches, with a focus of 63 inches. This remarkable instrument was constructed in 1870 for the total solar eclipse of 1871. With this Janssen found it easy to photograph the brightest parts of the nebula with comparatively short exposures. This extremely powerful photographic instrument seems to have been unused for the past fifteen years; but very recently it has been brought into use again, I understand, with the most astonishing results in photographing the nebulæ. Unfortunately for science, the death of Dr. Draper, in 1882, put a stop in America to the work he had inaugurated. But it was at once taken up in England by Common, who, with a three foot reflector, attained rapid and immediate success. His photographs of the great nebula of Orion are still classic. They were a great advance over the work of Draper, for the reflector was not only a larger telescope, but was also better adapted for photographic purposes, and especially for photographing the nebulæ. In January of 1883, with only 37 minutes' exposure, he secured what was by far the most striking and beautiful picture which had yet been taken of the great nebula. These pictures greatly extended the region of nebulosity, and the delicate details were also better shown.

The writer remembers how much he was impressed a few years later with the beauty of one of Common's photographs. It created in him the first ambition to do work of this kind. Indeed, this picture, and one of a densely crowded region of a part of the constellation of Cygnus, by the Henry Brothers, first called his attention to the great value of the photographic plate for astronomical purposes. It was at this time that the writer conceived the idea of photographing the Milky Way, though the experiments were not then successful, for the want of a proper instrument. The great nebula, which has always had a fascination for astronomers, was subsequently taken up by Isaac Roberts, who, by very prolonged exposures, still further extended the nebulous region and secured very beautiful pictures of it. Among the finest photographs of this object that have been made in recent years is one taken by Dr. H. C. Wilson at Northfield, Minn., with an 8-inch photographic refractor with an exposure of nine hours. The amount and sharpness of detail shown on this beautiful photograph is very striking, and essentially embraces all that has been done on this nebula by photography up to the present time.

The great nebula of Andromeda has been known to astronomers for upward of a thousand years, as it is a rather noticeable object with the naked eye. It has received its full share of attention ever since the invention of the telescope. It also appears to be a vast body of gaseous matter shining far away in the depths of space, but it seems to be in a different condition from that of the great nebula of Orion, for its spectrum is continuous and does not show the bright lines, indicating an incandescent gas, which are present in the spectrum of the Orion nebula. Though the mystery of its physical condition has not yet been solved, photography has at least shown us its true form. It has ceased to be the long spindle-shaped body of the elder Herschel, or the broad, irregular object, with two dark parallel channels in one side, as drawn by the Bonds and Trouvelot. The photographic plate reveals to us in their place a beautiful symmetrical mass of nebulous matter, surrounded with several more or less concentric rings, claimed by some astronomers to be a representation of the nebular hypothesis of La Place in full operation. The first picture to show the true form of this wonderful object was taken in 1885, with a 20-inch reflector by Roberts. It does not, however, require a powerful photographic telescope to show its peculiar features, for a 6-inch portrait lens will show the rings well with anything above one hour's exposure.

Important photographs of some of the spiral nebulæ, and especially of the "whirlpool nebula" of Lord Rosse, were made as early as 1888, by Von Gothard, with a 10-inch reflector. Excellent photographs of these objects have also been obtained by Dr. Roberts.

While it is absolutely necessary to use a considerable photographic telescope for the accurate registration of star positions, etc., where measures of precision are required, there are a great number of objects in the sky which are not necessarily subject to measurement, and which for their greatest value require a simple pictorial representation. The Milky Way, one of the most beautiful and certainly the most stupendous of the celestial features, is not susceptible of accurate measurement.

The individualizing and measurement of all its stars would be the most hopeless task imaginable. Nor would such a task be of any very great importance could it be accomplished as a whole, for we could not form any special idea of its structural peculiarities from such a work.

Though a conspicuous object to the unaided eye, the view we thus get of it is not sufficiently tangible, from the lack of details, to enable one to form any more than a crude idea of its coarser features. But even the naked-eye view of it is far more comprehensive than a catalogue would be containing accurate determinations of all its individual stars. What is required, therefore, in the study of this wonderful object—this mighty universe of stars—is something that will increase the penetration of our vision, and at the same time give us a certain amount of accuracy of position with a large field of view, so that we may study its peculiarities of structure in detail, and at the same time closely locate these details with reference to the whole, and thus, by finally putting structure and detail together, form a comprehensive idea, not only of the details themselves, but also of the relation of these features to each other. The long-focus telescope with a very limited field is not capable of dealing with the Milky Way in the manner stated.

Its structural details are very large, far larger in general than the field of view of the ordinary photographic telescope, and vastly greater than that of a powerful visual telescope. We want therefore a short-focus instrument, one capable not only of taking in a wide part of the sky, but also of giving a brilliant image, or, in other words, the reduction of the large details to a smaller scale, with a correspondingly great increase of effective light power. These conditions exist in the large portrait lenses which were needed in the early days of photography to reduce the exposure time by collecting a great quantity of light from the object, and which in these days of rapid dry plates are no longer required for portrait work. Taking in some ten or twelve degrees of the sky, these lenses are specially suitable for photographing large surfaces, such as are presented by the Milky Way.

This subject was taken up by the writer in the first part of 1889 at the Lick observatory, with a large 6-inch portrait lens of 31 inches focus, and with it was inaugurated the photography of the Milky Way. The first picture to show the real structure of the Milky Way was made in 1889 with this instrument. In the few following years a large series of photographs of those portions of the Milky Way seen from the northern hemisphere was made. The work with similar instruments was next taken up by Dr. Max Wolf, in Germany, who has also succeeded in making excellent pictures of the Milky Way. Mr. Russell, of Sydney, New South Wales, has also photographed portions of the southern part of the Milky Way, with a large portrait lens. Those who have seen some of the Milky Way photographs taken with the regular astro-photographic telescope, or who have tried to make out its complex structure with a visual telescope, must be struck with the great beauty of a photograph made with one of these short-focus portrait lenses.

The extraordinary complexity of structure of the Milky Way is brought out with marvelous beauty of detail, and the peculiarities of its different portions can be traced and connected in the different photographs, which thus afford the most direct means for studying every feature of structure and detail. These pictures show many peculiarities which must materially alter our ideas of the constitution and structure of the Milky Way. Some of them show strong evidence that the general body of the Milky Way may be made up of small stars which are not at all comparable with our sun in dimensions. This is especially shown in the region of the star Rho Ophiuchi. Many parts of the Milky Way appear to be comparatively thin sheetings of stars with relatively no very great depth, for it is not possible otherwise to explain the black holes and rifts shown in them.

One of the most important revelations made by the portrait lens in connection with the Milky Way is the presence in it of very diffused nebulous matter apparently freely mixed with the groundwork of stars, and seemingly showing no definite tendency to condensation about the individual stars. These photographic nebulosities of the Milky Way are apparently of a different nature from the ordinary nebulæ of the sky, since they are extraordinarily large, diffused and but feebly luminous. These nebulous regions seem to be peculiar to the Milky Way and its vicinity, and are certainly in some way physically connected with it. It will be in the study by photography of such regions that we shall finally clear away some of the mysteries of the Milky Way. These masses of diffused nebulosity mainly affect regions of the sky in Scorpio, Cygnus, Cepheus, Perseus and Monoceros. I believe it to be true that no other form of telescope but the old time portrait lens or similar combination is capable of dealing with these extraordinary objects.

(To be continued.)

Aluminum has lately found its way extensively into vibrating and reciprocating machines, both large and small. Here the advantageous use of the metal is entirely a matter of reducing the weight, says The Engineer. Probably the best illustration of the use of aluminum in revolving machinery is in using an oil cup on the driving wheel of a locomotive in connection with a driving rod. With the increased speeds that the roads are now aiming to attain, it is necessary to increase the diameter of the driving wheels, and, consequently, the tendency to break the shank of the oil cups materially increases, and with some of the large engines which have been built cups made of composition are frequently broken. These cups, says an American exchange, are now, and have been for some time, successfully cast in aluminum, and have given great satisfaction.

Selenium is now used for coloring glass. Rose-tinted glass is made by adding selenium directly to ingredients in the melting pot. By mixing first with cadmium sulphide, orange red is produced. This process is stated not to require the reheating of the glass and its immersion in a coloring mixture, as in the ordinary process of making red glass. Whether selenium glass is suited for photographic work remains to be seen.—Engineering and Mining Journal.

VALUABLE BOOKS.

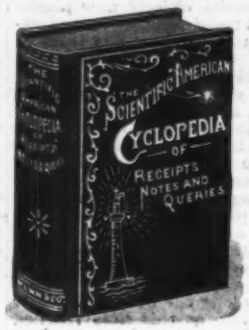
THE SCIENTIFIC AMERICAN

CYCLOPEDIA of RECEIPTS, NOTES and QUERIES

EDITED BY ALBERT A. HOPKINS.

12,500 Receipts, 708 Pages.

Price, $5 in cloth; $6 in sheep; $6.50 in half morocco; Postpaid



This splendid work contains a careful compilation of the most useful Receipts and Replies given in the Notes and Queries of correspondents as published in the SCIENTIFIC AMERICAN during the past fifty years; together with many valuable and important additions.

Over twelve thousand selected receipts are here collected; nearly every branch of the useful arts being represented. It is by far the most comprehensive volume of the kind ever placed before the public.

The work may be regarded as the product of the studies and practical experience of the ablest chemists and workers in all parts of the world; the information given being of the highest value, arranged and condensed in concise form, convenient for ready use.

Almost every inquiry that can be thought of, relating to formulæ used in the various manufacturing industries, will here be found answered.

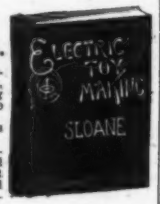
Those who are in search of independent business or employment, relating to the home manufacture of salable articles, will find in it hundreds of most excellent suggestions.

ELECTRIC TOY MAKING.

DYNAMO BUILDING AND ELECTRIC MOTOR CONSTRUCTION.

BY PROF. T. O'CONOR SLOANE.

140 Pages, Very Fully Illustrated, Price $1.00.

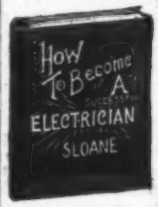


This work treats of the making at home of electrical toys, electrical apparatus, motors, dynamos, and instruments in general, and is designed to bring within the reach of young and old the manufacture of genuine and useful electrical appliances.

The work is especially designed for amateurs and young folks.

Thousands of our young people are daily experimenting, and busily engaged in making electrical toys and apparatus of various kinds. The present work is just what is wanted to give the much needed information in a plain, practical manner, with illustrations to make easy the carrying out of the work.

How to Become a Successful Electrician.



BY PROF. T. O'CONOR SLOANE.

189 Pages, Illustrated, $1.00.

It is the ambition of thousands of young and old to become electrical engineers. Not every one is prepared to spend several thousand dollars upon a college course, even if the three or four years requisite are at their disposal. It is possible to becom an electrical engineer without this sacrifice, and this work is designed to tell "How to Become a Successful Electrician," without the outlay usually spent in acquiring the profession.

Electricity Simplified.

BY PROF. T. O'CONOR SLOANE.

158 Pages, Fully Illustrated, Price, $1.00.

This work is the simplest ever published on the subject. Electricity is in many respects unexplained by the scientist; to the ordinary man it is all a mystery. This book makes the subject as plain as possible. Shows how two plates of different metals immersed in acid can send a message around the globe; how a bundle of copper wire rotated by a steam engine can be the agent in lighting our homes and streets, etc. By illustrations of original design and scope, the subject is made exceedingly simple.

ARITHMETIC OF ELECTRICITY.

By PROF T. O'CONOR SLOANE.

138 Pages, Illustrated, Price, $1.00.

A PRACTICAL Treatise on Electrical Calculations of all kinds reduced to a series of rules, all of the simplest forms, and involving only ordinary arithmetic; each rule illustrated by one or more practical problems, with detailed solution of each one. Followed by an extensive series of Tables, including the following subjects: All Kinds of Units of Measurement of Electrical and Mechanical Work, Energy and Heat; Relations of Different Systems of All Kinds of Units; Relation of Different Wire Gages, American and Foreign; Electrical Properties of Wire of Different Sizes; Specific Resistances; Thermo-chemical and Electro-chemical Equivalents; Useful Factors, etc., etc.

This book may be classed among the most useful works published on the science of electricity, covering, as it does, the mathematics of electricity in a manner that will attract the attention of those who are not familiar with algebraical formulæ.

Standard Electrical Dictionary

BY PROF. T. O'CONOR SLOANE.

682 Pages, 393 Illustrations. Handsomely Bound in Cloth, 8vo, $3.00.

☞ An Entirely New Edition, Brought Up To Date and Greatly Enlarged. Complete—Concise—Convenient.

The large sales of the author's previous works, and the flattering reviews they have received from all sources, together with the great demand for a dictionary of this kind, have led Prof. Sloane to complete, after a vast amount of labor, a work of a very high standard.

In publishing the "Standard Electrical Dictionary," he has adhered to what the work purports to be, exhausting the subject of electrical terms, giving each title the clearness of explanation necessary to make the understanding of it complete without unnecessary elaboration. In this work, every electrical word, term, or phrase will be found intelligently defined.

A practical handbook of reference, containing definitions of about 5,000 distinct words, terms and phrases.

The work is absolutely indispensable to all in any way interested in electrical science, from the higher electrical expert to the everyday electrical workman. In fact, it should be in the possession of all who desire to keep abreast with the progress of this branch of science.

The above five volumes, comprising a **Complete Electrical Library,** sold at the *special reduced* price of **$5.00** put up in a neat folding box.

You save $2.00 by ordering the set complete. 5 volumes, 1,300 pages, over 450 illustrations.

☞ Send for special circular containing full table of contents of the above books.

MUNN & CO., 361 Broadway, New York.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers, 361 Broadway, New York.

TABLE OF CONTENTS.

PAGE

I. ASTRONOMY.—The Development of Photography in Astronomy. 19032

II. BOTANY AND HORTICULTURE.—The Machineel or Manzanilla Tree.—1 illustration. 19043
Veronica Dieffenbachii.—1 illustration. 19043

III. ECONOMICS.—Inaugural Address by Sir WILLIAM CROOKES, F.R.S., V.P.C.S., President of the British Association. 19018

IV. ELECTRICITY.—A New Incandescent Filament for Electric Lights. 19011
Death by Electricity.—By W. S. HEDLEY, M.D. 19049
The Telephone in Italy. 19041

V. HOROLOGY.—The Division of Clock Dials.—4 illustrations. 19046

VI. MINES.—The Mineral Resources of Persia. 19032

VII. MISCELLANEOUS.—A Peculiar Style of Ladder.—2 illustrations. 19040
Engineering Notes. 19045
Miscellaneous Notes. 19045
Selected Formulæ. 19045

VIII. NATURAL HISTORY.—The Dispersion of Molluska.—6 illustrations. 19042

IX. PAPER.—Papyristite. 19046

X. PHYSICAL GEOGRAPHY.—Bottle Drifts.—By HENRY C. WEEKS.—1 illustration. 19040
The Earthquakes in Dalmatia.—1 illustration. 19041

XI. PHYSICS.—Color Vision. 19041
The Spiral Bottle.—1 illustration. 19041

XII. TECHNOLOGY.—Babbitt Metal.—By C. VICKERS. 19044

XIII. TRAVEL AND EXPLORATION.—The French on the Upper Nile.—2 illustrations. 19039
Use of Bamboo Among the Annamites.—2 illustrations. 19047

XIV. WARMING.—Greenhouse Heating.—By THOMAS N. THOMSON.—3 illustrations. 19043

SPECIAL NAVAL SUPPLEMENT, No. 1165,

contains a historical review of the modern United States navy, the classification of the various forms of war vessels and nearly one hundred illustrations, including details of construction of such vessels not found in any other publication. A map of Cuba printed in five colors accompanies it. Price, 25 cents. Single copies sent by mail in United States, Canada and Mexico. Foreign countries, 8 cents extra.

MUNN & CO., 361 Broadway, New York.

THE SCIENTIFIC AMERICAN

Army and Coast Defence Supplement

GUNS, ARMOR AND FORTIFICATIONS.

The present number is uniform in size with our Special Navy Supplement, which has attracted such wide attention. It treats of guns and gun carriages for Army and Navy use and Coast Defence, including disappearing gun carriages, rapid fire guns, machine guns, mortars, etc., with special reference to their construction and operation. This section of the paper is profusely illustrated with drawings which enable their operation to be readily understood by the lay reader. The subject of projectiles, powders, gun cotton, etc., is also fully treated; range finders, torpedoes, submarine mines and armor are all fully described and illustrated. There is also a section devoted to the small arms of the Army and Navy, together with an account of the organization of the Army, with fine engravings of prominent Generals. Never before have these subjects been treated in such a popular way. The illustrations number over 100 and include a magnificent double page Supplement of our largest battleship, the "Iowa." The whole is enclosed in a handsome cover, showing a large coast defence gun in action.

Price by mail, 25 cents; to foreign countries, 35 cents.

MUNN & CO., Publishers, 361 Broadway, New York

BUILDING EDITION

OF THE

SCIENTIFIC AMERICAN.

Those who contemplate building should not fail to subscribe.

ONLY $2.50 A YEAR.

Semi-annual bound volumes $2.00 each, yearly bound volumes $3.50 each, prepaid by mail.

Each number contains elevations and plans of a variety of country houses; also a handsome

COLORED PLATE.

MUNN & CO., 361 Broadway, New York.

PATENTS!

MESSRS. MUNN & CO., in connection with the publication of the SCIENTIFIC AMERICAN, continue to examine improvements, and to act as Solicitors of Patents for Inventors.

In this line of business they have had *fifty years' experience*, and now have *unequaled facilities* for the preparation of Patent Drawings, Specifications, and the prosecution of Applications for Patents in the United States, Canada, and Foreign Countries. Messrs. Munn & Co. also attend to the preparation of Caveats, Copyrights for Books, Trade Marks, Reissues, Assignments, and Reports on Infringements of Patents. All business intrusted to them is done with special care and promptness, on very reasonable terms.

A pamphlet sent free of charge, on application containing full information about Patents and how to procure them; directions concerning Trade Marks, Copyrights, Designs, Patents, Appeals, Reissues, Infringements, Assignments, Rejected Cases, Hints on the Sale of Patents, etc.

We also send, *free of charge*, a Synopsis of Foreign Patent Laws showing the cost and method of securing patents in all the principal countries of the world.

MUNN & CO., Solicitors of Patents,
361 Broadway, New York

BRANCH OFFICES.—No. 625 F Street, Washington, D. C.

898.

ent.

in any
ollars a

om the
Price,

an like-
yearly,
or $3.50

AMERI-
UPPLE-

nts, and

York.

PAGE
my. 1902

zan-
..... 1943
..... 1943

KES,
..... 1918

ctric
..... 1911
..... 1909
..... 1904

..... 1946

..... 1902

tra-
..... 1940
..... 1945
..... 1945
..... 1945

lus-
..... 1902

..... 1946

C.
..... 1910
..... 1941

..... 1931
..... 1941

..... 1914

per
..... 1939
..... 1947

OM-
..... 1943

5,

classifi-
illustra-
d in any
panies it.
nada and

York.

ent

Supple-
and gun
sappear-
h special
he paper
ion to be
owders,
bmarine
is also a
her with
rings of
reated in
e a mag-
"Iowa."
defence

w York

ON

ail to

yearly

of a

rk.

S!

ublica-
examine
for In-

nd now
Specifi-
United
tend to
issues.
ness in-
reason-

nforma-
Trade
ements.

howing
ries of